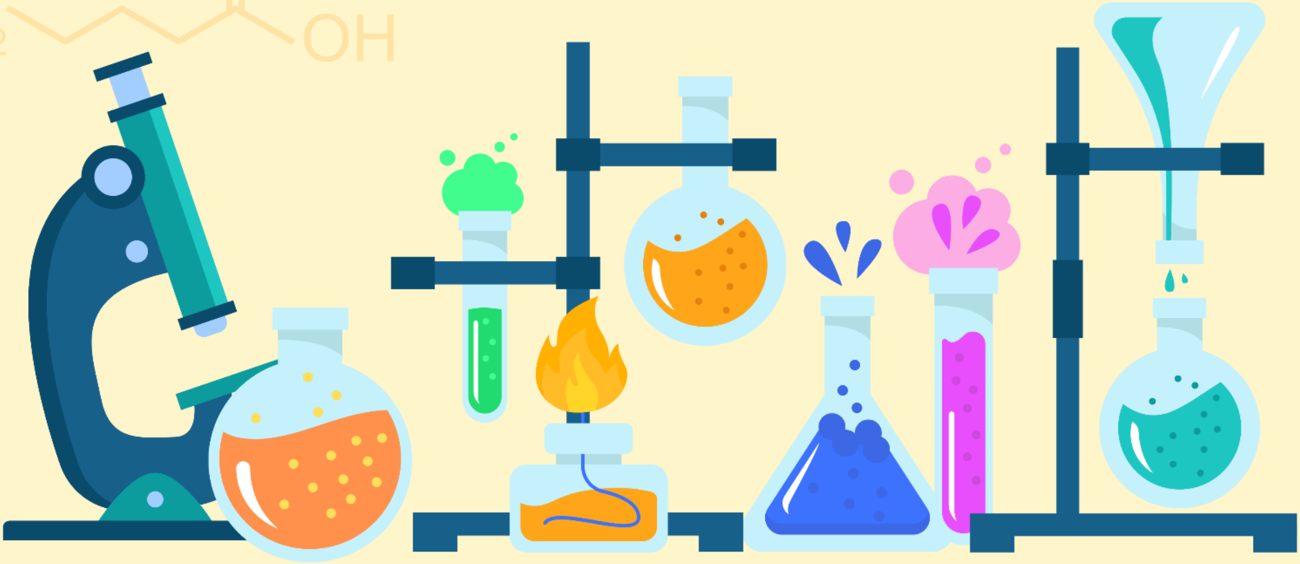
केंद्रीय विद्यालय संगठन

रायपुर संभाग



STUDY CAPSULE

VOLUME II

कक्षा - XII

सत्र - 2025-26

रसायन विज्ञान
CHEMISTRY

तत् त्वं पूषन् अपावृणु
केन्द्रीय विद्यालय संगठन

SESSION-2025-26

KENDRIYA VIDYALAYA SANGATHAN, RAIPUR REGION

OUR MENTORS

Mrs. P.B.S.USHA
Deputy Commissioner
Kendriya Vidyalaya Sangathan,
Regional Office, Raipur

Shri. Vivek Kumar Chauhan
Assistant Commissioner
Kendriya Vidyalaya Sangathan,
Regional Office, Raipur

Shri. Ravindra Kumar,
Assistant Commissioner
Kendriya Vidyalaya Sangathan,
Regional Office, Raipur

COURSE COORDINATOR

Mr. Shersingh Rajpoot
Principal,K.V.Bacheli
Dist. Dantewada(C.G.)

RESOURCE PERSON

1. Mr. Wasim Khan, PGT(Chemistry), K.V. Dongargarh
2. Mrs. Sweta Bajpai, PGT(Chemistry), K.V.Raipur No. 02

VETTED BY:

1. Santosh Kumar Chaini , PGT(Chemistry), K.V. Raigarh
2. Yashwanti Sahu, PGT(Chemistry), K.V.Raipur No. 01
3. Rohita Bansod, PGT(Chemistry), K.V. Mahasamund
4. Farhana Khan, PGT(Chemistry), K.V. BMY Bhilai
5. Sheela Chacko, PGT(Chemistry), K.V. Durg

CONTENT DEVELOPER TEAM FOR VOL-II (2025-26)

S.NO.	CHAPTER'S NAME	NAME OF TEACHER	NAME OF KENDRIYA VIDYALAYA
1.	SOLUTIONS	SANTOSH KUMAR CHAINI	K.V. RAIGARH
		VIJAY KUMAR SAHU	K.V. AMBUKAPUR
2.	ELECTROCHEMISTRY	DIMPLE PAREEK	K.V. BILASPUR
		SUNEETA GAWANDE	K.V. CISF BHILAI
3.	CHEMICAL KINETICS	YASHWANTI SAHU	K.V. RAIPUR NO 1 S-II
		NEELAM SINGH	K.V. CRPF BILASPUR
		DASHRATH	K.V. BIJAPUR
4.	d- & f- BLOCK ELEMENTS	ROHITA BANSOD	K.V. MAHASAMUND
		ASHVAJEET DIVE	K.V. BACHELI
5.	CO-ORDINATION COMPOUNDS	RICHA YADAV	K.V. DANTEWADA
		SANGEET SONI	K.V. RAJNANDGAON
6.	HALOALKANES & HALOARENES	VIMMI THOMAS	K.V. RAIPUR NO 1 S-I
		DESHRAJ	K.V. BAIKUNTHPUR
7.	ALCOHOLS, PHENOLS & ETHERS	SHEELA CHACKO	K.V. DURG
		ANITA	K.V. KIRANDUL
		JYOTI RANI	K.V. KORBA NO II (NTPC)
8.	ALDEHYDES, KETONES & CARBOXYLIC ACIDS	FARHANA KHAN	K.V. BMY BHILAI
		SHIVANI YADAV	K.V. NARAYANPUR
		EKTA SHEORAN	K.V. JHAGRAKHAND
9.	AMINES	NEM SINGH	K.V. KURUD
		MEENAKSHI	K.V. RAIPUR NO 2
10.	BIOMOLECULES	VISHNUPRIYA MEENA	K.V. JASHPUR
		S K GIRI	K.V. NAYA RAIPUR

INDEX

COURSE STRUCTURE CLASS XII
CHEMISTRY (THEORY)

Time: 3 Hours Total Marks: 70

S. No.	Title	Marks
1	Solutions	7
2	Electrochemistry	9
3	Chemical Kinetics	7
4	d -and f -Block Elements	7
5	Coordination Compounds	7
6	Haloalkanes and Haloarenes	6
7	Alcohols, Phenols and Ethers	6
8	Aldehydes, Ketones and Carboxylic Acids	8
9	Amines	6
10	Biomolecules	7
Total		**70**

Unit 1: Solutions

Types of solutions, expression of concentration of solutions of solids in liquids, solubility of gases in liquids, solid solutions, Raoult’s law, colligative properties - relative lowering of vapor pressure, elevation of boiling point, depression of freezing point, osmotic pressure, determination of molecular masses using colligative properties, abnormal molecular mass, Van't Hoff factor

Unit 2: Electrochemistry

Redox reactions, EMF of a cell, standard electrode potential, Nernst equation and its application to chemical cells, Relation between Gibbs energy change and EMF of a cell, conductance in electrolytic solutions, specific and molar conductivity, variations of conductivity with concentration, Kohlrausch's Law, electrolysis and law of electrolysis (elementary idea), dry cell-electrolytic cells and Galvanic cells, lead accumulator, fuel cells, corrosion.

Unit 3: Chemical Kinetics

Rate of a reaction (Average and instantaneous), factors affecting rate of reaction: concentration, temperature, catalyst; order and molecularity of a reaction, rate law and specific rate constant, integrated rate equations and half-life (only for zero and first order reactions), concept of collision theory (elementary idea, no mathematical treatment), activation energy, Arrhenius equation.

Unit 4: d and f Block Elements

General introduction, electronic configuration, occurrence and characteristics of transition metals, general trends in properties of the first row transition metals — metallic character, ionization enthalpy, oxidation states, ionic radii, colour, catalytic property, magnetic properties, interstitial compounds, alloy formation, preparation and properties of K2Cr2O7 and KMnO4.

Lanthanides - Electronic configuration, oxidation states, chemical reactivity and lanthanide contraction and its consequences.

Actinides - Electronic configuration, oxidation states and comparison with lanthanides

Unit 5: Coordination Compounds

Coordination compounds - Introduction, ligands, coordination number, colour, magnetic properties and shapes, IUPAC nomenclature of mononuclear coordination compounds. Bonding, Werner's theory, VBT, and CFT; structure and stereoisomerism, importance of coordination compounds (in qualitative analysis, extraction of metals and biological system).

Unit 6: Haloalkanes and Haloarenes

Haloalkanes: Nomenclature, nature of C–X bond, physical and chemical properties, optical rotation mechanism of substitution reactions.
Haloarenes: Nature of C–X bond, substitution reactions (Directive influence of halogen in monosubstituted compounds only).
Uses and environmental effects of - dichloromethane, trichloromethane, tetrachloromethane, iodoform, freons, DDT.

Unit 7: Alcohols, Phenols and Ethers

Alcohols: Nomenclature, methods of preparation, physical and chemical properties (of primary alcohols only), identification of primary, secondary and tertiary alcohols, mechanism of dehydration, uses with special reference to methanol and ethanol.
Phenols: Nomenclature, methods of preparation, physical and chemical properties, acidic nature of phenol, electrophilic substitution reactions, uses of phenols.
Ethers: Nomenclature, methods of preparation, physical and chemical properties, uses

Unit 8: Aldehydes, Ketones and Carboxylic Acids

Aldehydes and Ketones: Nomenclature, nature of carbonyl group, methods of preparation, physical and chemical properties, mechanism of nucleophilic addition, reactivity of alpha hydrogen in aldehydes, uses**Carboxylic Acids:** Nomenclature, acidic nature, methods of preparation, physical and chemical properties; uses.

Unit 9: Amines

Amines: Nomenclature, classification, structure, methods of preparation, physical and chemical properties, uses, identification of primary, secondary and tertiary amines.
Diazonium salts: Preparation, chemical reactions and importance in synthetic organic chemistry.

Unit 10: Biomolecules

Carbohydrates - Classification (aldoses and ketoses), monosaccahrides (glucose and fructose), D-L configuration oligosaccharides (sucrose, lactose, maltose), polysaccharides (starch, cellulose, glycogen); Importance of carbohydrates.

Proteins -Elementary idea of - amino acids, peptide bond, polypeptides, proteins, structure of proteins - primary, secondary, tertiary structure and quaternary structures (qualitative idea only), denaturation of proteins; enzymes. Hormones - Elementary idea excluding structure.
Vitamins - Classification and functions. **Nucleic Acids:** DNA and RNA

PRACTICAL

Evaluation Scheme for Examination	Marks
Volumetric Analysis	08
Salt Analysis	08
Content Based Experiment	06
Project Work	04
Class record and viva	04
Total	**30**

QUESTION PAPER DESIGN CLASSES XI & XII

S.No	Domains	Total Marks	%
1	**Remembering and Understanding:** Exhibit memory of previously learned material by recalling facts, terms, basic concepts and answers. Demonstrate understanding of facts and ideas by organizing, comparing, translating, interpreting, giving descriptions and stating main ideas.	28	40
2	**Applying:** Solve problems to new situations by applying acquired knowledge, facts, techniques and rules in a different way.	21	30
3	**Analysing, Evaluating and Creating:** Examine and break information into parts by identifying motives or causes. Make inferences and find evidence to support generalizations. Present and defend opinions by making judgments about information, validity of ideas or quality of work based on a set of criteria. Compile information together in a different way by combining elements in a new pattern or proposing alternative solutions.	21	30

1. No chapter wise weightage is provided, however, care to be taken to cover all the chapters.
2. Suitable internal variations may be made for generating various templates.
3. There will be no overall choice in the question paper.
4. However, 33% internal choices will be given in all the sections.

CHAPTER :- 1 SOLUTION

1	The system that forms maximum boiling azeotrope is : (A) Carbon disulphide – acetone (B) Benzene – Toluene (C) Acetone – Chloroform (D) n-Hexane - n-Heptane
2	Scuba divers when go in deep sea face a very painful situation known as "bends", the formation of N_2bubbles around the joints due to decrease in solubility of N_2 as a result of reduced pressure, when the diver rises up towards sea surface. This situation is avoided by: (A) Taking only pure O_2 in breathing cylinders. (B) Replacing some N_2 by He, which is more soluble than N_2. (C) Replacing some N_2 by He, which is less soluble than N_2. (D) This situation can not be avoided and therefore pain killers are consumed.
3.	The abnormal molecular mass of CH_3COOH when dissolved in benzene is found to be 80 g/mol. The percentage of CH_3COOH present in dimeric form in solution is: (A) 50% (B) 12.75% (C) 25% (D) 33.33%
4.	Equal weight of NaCl and KCl are dissolved separately in equal volumes of solutions then molarity of the two solutions will be: (A) Equal (B) That of NaCl will be less than that of KCl (C) That of NaCl will be more than that of KCl solution (D) That of NaCl will be half of that of KCl solution
5.	Low concentration of oxygen in the blood and tissues of people living at high altitude is due to: (A) Low temperature (B) Low atmospheric pressure (C) High atmospheric pressure (D) Both low temperature and high atmospheric pressure
6.	If 0.1 M solution of glucose and 0.1 M urea solution are placed on two sides of a semipermeable membrane to equal heights, then it will be correct to say that: (A) There will be no net movement across the membrane (B) Glucose will flow towards urea solution (C) Urea will flow towards glucose solution (D) Water will flow from urea solution towards glucose solution.
7.	Which aq. solution has the highest osmotic pressure at 25°C? (Assume all ionic compounds ionize completely in solution) (A) 0.1M $Al_2\,(SO\ )_3$ (B) 0.1M Na_2CO_3 (C) 0.2M $KMnO_4$ (D) 0.1M $C_2\,H_{12}\,O_6$
8.	A 5% solution of Cane-Sugar (Mol. Wt. = 342) is isotonic with 1% solution of a substance "A". The molecular weight of "A" is: (A) 34.2 (B) 68.4 (C) 171.2 (D) 136.8
9.	A solution containing 4g of polyvinyl chloride in 1 litre of dioxane was found to have an osmotic pressure of 6×10^{-4} atm at 300 K. The molecular mass of polymer is: (A) 3×10^3 (B) 1.6×10^5 (C) 5×10^4 (D) 6.4×10^2
10.	Water & HNO_3 form a non ideal solution. If 36 g of water is mixed with 126 g of HNO_3. Vapor pressure of water and HNO_3 in pure state at 298 K are 360 torr & 300 torr respectively then what could be the vapour pressure of the above solution at 298 K? (A) 330 torr (B) 350 torr (C) 250 torr (D) 370 torr
11.	In a chemistry laboratory, Richa took 5g of a solute from an unknown box and prepared a 0.25 M basic solution. The volume of the solution was 500 ml. Based on the above data, which of the following is likely to be the unknown substance used by Richa?

	(Approx. Atomic masses of Ca = 40 u; Na = 23 u; Li = 7 u; Cs = 133 u; O = 16 u; H = 1 u) A) Ca(OH)2 B) NaOH. C) LiOH. D) CsOH
12	A mixture of acetone and chloroform forms a maximum boiling azeotrope at a specific composition. Which of these is CORRECT for the mixture? A. Change in volume on mixing will be positive. B. Change in enthalpy on mixing will be positive. C. Interaction between unlike molecules is stronger than that between like molecules in the mixture. D. The proportion of acetone and chloroform in the mixture in the liquid phase is not the same as in the vapor phase
13	As per Henry's law K_H= p/x; where p is the partial pressure, x is the mole fraction of the gas, and K_H is the Henry law constant. If, the concentration of N_2 gas in water at constant pressure increases quadratically, how will the value of K_H change? A. Increases linearly B. Decreases quadratically C. Decreases linearly D. Remains the same
14	$P A$ and PB are the vapour pressure of pure liquid components, A and B, respectively of an ideal binary solution. If XA represents the mole fraction of component A, the total pressure of the solution will be. (A) $P A + XA(PB - P A)$ (B) $P A + XA(P A - PB)$ (C) $PB + XA(PB - P A)$ (D) $PB + XA(P A - PB)$

ANSWER MCQs

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
C	C	A	C	B	A	A	B	B	C
11	**12**	**13**	**14**						
B	C	D	D						

Assertion-Reason

Choose correct option from following for the given question.

(A) Both Assertion & Reason arc True & the Reason is a correct explanation of the Assertion
(B) Both Assertion & Reason arc True but Reason is not a correct explanation of the Assertion
(C) Assertion is True but Reason is false
(D) Assertion is false but Reason is true.

1. **Assertion :** No solvent flows across SPM separating two isotonic solutions.
   Reason : Isotonic solutions have same osmotic pressure.

2. **Assertion :** Addition of ethylene glycol (non volatile) to water lowers the freezing point of water hence used as antifreeze.
   Reason : Addition of any substance to water lowers the freezing point.

3. **Assertion:** Cooking time is reduced in pressure cookers.
   Reason: Boiling point of water inside the pressure cooker is raised.

4. **Assertion:** When NaCl is added to water a depression in the freezing point is observed.
   Reason: The lowering of the vapour pressure of a solution causes depression in the freezing point.

5. **Assertion :** If one component of a solution obeys Raoult's law over a certain range of composition, the other component will not obey Henry's law in that range.
   Reason : Raoult's law is a special case of Henry's law.

ANSWER

1	2	3	4	5
A	C	A	A	B

TWO MARKS

1. Concentration terms such as mass percentage, ppm, mole fraction and molality are independent of temperature, however molarity is a function of temperature. Explain.
2. What is the significance of Henry's Law constant K_H ?
3. Define azeotropes with one example of each type. Rakesh took 20 g of solute A to prepare a 50 ml solution. This solution is isotonic to another solution of the same volume with a weight of 40 g of a different solute B.
   a) If both the solution is prepared at the same temperature, then what is the ratio of molecular mass of solute A to that of B?
   b) If the two solutions are placed at different temperatures, keeping all other variables constant, and separated by SPM, will the osmosis happen, and why?
4. A solution containing two non-interacting solid solutes A and B in the mass ratio 5:1 is isotonic with another solution of A and B (with the same volume) having a mass ratio of 3:5. What is the ratio of the molar mass of A: B?
5. State Henry's law. What is the effect of temperature on the solubility of a gas in a liquid?
6. The partial pressure of ethane over a saturated solution containing 6.56×10^{-2} g of ethane is 1 bar. If the solution contains 5.0×10^{-2} g of ethane, then what will be the partial pressure of the gas?
7. Solution is prepared by dissolving 10 g of non-volatile solute in 200 g of water. It has a vapour pressure of 31.84 mm Hg at 308 K. Calculate the molar mass of the solute.
   (Vapour pressure of pure water at 308 K = 32 mm Hg)
8. The osmotic pressure of a 0.0103 molar solution of an electrolyte was found to be 0.75 atm at 27°C. Compute Van't Hoff factor.
9. Calculate the volume of water which could be added to 20 ml of 0.65 m HCl to dilute the solution to 0.2 m?
10. Show graphically the depression in freezing point on adding a non volatile solute?

Three marks Questions

1. Why are aquatic species more comfortable in cold water in comparison to warm water?
2. Why do colligative properties of solution of a given concentration are found to give abnormal molecular weight of solute. Explain with the help of suitable examples.

3. A solution prepared by dissolving 1.25 g of oil of winter green (methyl salicylate) in 99.0 g of benzene has a boiling point of 80.31°C. Determine the molar mass of this compound. (B.P. of pure benzene = 80.10°C and K_b for benzene = 2.53°C kg mol^{-1})
4. The freezing point depression constant (K_f) for water is 1.86°C/m. Assumevan't Hoff factor for NaCl is 1.87. (Molar mass of NaCl = 58.5 g)
5. If N_2 gas is bubbled through water at 293K, how many millimoles of N_2 gas would dissolve in 1 litre of water? Assume that N_2 exerts a partial pressure of 0.987 bar. Given that Henry's law constant for N_2 at 293K is 76.48 k bar.
6. Some ethylene glycol, $HOCH_2CH_2OH$, is added to your car's cooling system along with 5 kg of water. If the freezing point of a water-glycol solution is -15.0°C, what is the boiling point of the solution?
   (K_b = 0.52 K kg mol^{-1} and K_f = 1.86 K kg mol^{-1} for water)
7. 3.9 g of benzoic acid dissolved in 49 g of benzene shows a depression in freezing point of 1.62 K. Calculate the Van't Hoff factor and predict the nature of solute (associated or dissociated).
8. Find the molality and molarity of a 15% solution of H_2SO_4 when its density is 1.10 $glcm^3$ & molar mass = 98 amu.
9. State the amount of urea (mol. mass 60 g/mol) that must be dissolved in 50g of water so as the vapour pressure at the room temperature is reduced by 25%? Evaluate the molality of the solution obtained as well.
10. Nalorphine $C_{19}H_{21}NO_3$, similar to morphine, is used to combat withdrawal symptoms in narcotic users. Dose of nalorphene generally given is 1.5 mg. Calculate the mass of $1.5x10^{-3}$ m aqueous solution required for the above dose.
11. Shweta mixed two liquids A and B of 10 mL each. After mixing, the volume of the solution was found to be 20·2 mL.
    i. Why was there a volume change after mixing the liquids ?
    ii. Will there be an increase or decrease of temperature after mixing ?
    iii. Give one example for this type of solution
12. The table below shows the degree of dissociation/association along with constant i for different solutes.

Solute	Degree of association or dissociation	i
H_2SO_4	1	3
CH_3COOH (in water)	0.2	-
CH_3COOH (in benzene)	0.5	-
Urea	No asso ciation or dissociation	1

Based on the table:

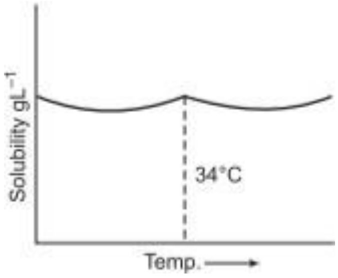
(i) What is the Vant Hoff factor i for CH_3COOH in two different solvents? *(Assume 100% association or dissociation)*

(ii) Why does Urea show no association or dissociation in any solvent?

Case Study 1

Binary solutions can be of nine different types depending upon the nature of the solute and solvent whether solid, liquid or gas. They may be further classified as solid, liquid and gaseous solutions based on the component which acts as the solvent. However, the liquid solutions are the most important. Both solids and gases dissolve in liquids resulting in homogeneous mixtures, i.e. solutions. The solubility is governed by number of factors such as nature of solute and solvent, temperature, pressure etc. The concentrations of the solutions can be expressed in different ways such as normality, molarity, molality, mole fraction etc. Out of these, molality and mole fraction are better as they do not change with the change in temperature.

Q1. Solubility curve of $Na_2SO4-10H20$ in water with temperature is given as:



a. solubility process is exothermic
b. solubility process is exothermic till 34°C and endothermic after 34°C
c. solubility process is endothermic till 34°C and exothermic after -34°C
d. solubility process is endothermic

Q2. $CuSO_4.5H_2O$ is a:
a. solution of solid in a liquid
b. solution of liquid in a solid
c. salt only and cannot be called a solution
d. co-ordination compound of copper with water molecules as the ligand

Or

The molality of a sulphuric acid solution in which mole fraction of water is 0.85 is:
a. 9.80. b) 10.58. c) 10.50. d) 11.25

Q3. Maximum amount of a solid solute that can be dissolved in a specified amount of a given liquid solvent does not depend upon:
a. Temperature. b) pressure c) nature of solute. d) nature of solvent

Q4. Alloy is which type of solution?

Case Study 2

The four colligative properties of the dilute solutions help in calculating the molecular mass of the solute which is often called observed molecular mass. It may be same as the theoretical molecular mass (calculated from the molecular formula) if the solute behaves normally in solution. In case, it undergoes association or dissociation, the observed molar mass gives different results. The nature of the solute in solution is expressed in terms of van't Hoff factor (i) which may be 1 (if the solute behaves normally), less than 1 (if the solute associates) and more than 1 (if the solute dissociates). The extent of association or dissociation is represented by a which is:

$$\alpha = \frac{i-1}{(1/n-1)} \quad \text{or} \quad \frac{i-1}{n-1}$$

(for association) (for dissociation)

Q1. What is common in all the four colligative properties?
Q2. What is the value of van't Hoff factor for a dilute solution of K_2SO_4 in water?

OR

In the determination of molar mass of A*B- using colligative property, what will be the van't Hoff factor if the solute is 40% dissociated?
Q3. What is the expected value of van't Hoff factor for $K_4[Fe(CN)_6]$ when it completely dissociates in water?
Q4. When van't Hoff factor is greater than one?

Case study3

Few colligative properties are:
(a) relative lowering of vapour pressure: depends only on molar concentration of solute (mole fraction) and

independent of its nature.
(b) depression in freezing point: it is proportional to the molal concentration of solution.
(c) elevation of boiling point: it is proportional to the molal concentration of solute.
(d) osmotic pressure : it is proportional to the molar concentration of solute.
A solution of glucose is prepared with 0.052 g at glucose in 80.2 g of water. (K_f = 1.86 K kg mol^{-1} and K_b = 5.2 K kg mol^{-1})

The following questions are multiple choice questions. Choose the most appropriate answer:
(i) Molality of the given solution is
(a) 0.0052 m. (b) 0.0036 m. (c) 0.0006 m. (d) 1.29 m
(ii) Boiling point for the solution will be
(a) 373.05 K (b) 373.15 K. (c) 373.02 K (d) 372.98 K

Or

The depression in freezing point of solution will be
(a) 0.0187 K. (b) 0.035 K. (c) 0.082 K. (d) 0.067 K
(iii) Mole fraction of glucose in the given solution is
(a) 6.28×10^{-5} (b) 1.23×10^{-4} (c) 0.00625. (d) 0.00028
(iv) When blood cells shrink in saline solution?

Case study 5

The spontaneous flow of the solvent through a semipermeable membrane from a pure solvent to a solution or from a dilute solution to a concentrated solution is called osmosis. The phenomenon of osmosis can be demonstrated by taking two eggs of the same size. In an egg, the membrane below the shell and around the egg material is semipermeable.
The outer hard shell can be removed by putting the egg in dilute hydrochloric acid. After removing the hard shell, one egg is placed in distilled water and the other in a saturated salt solution. After some time, the egg placed in distilled water swells-up while the egg placed in salt solution shrinks. The external pressure applied to stop the osmosis is termed as osmotic pressure (a colligative property). Reverse osmosis takes place when the applied external pressure becomes larger than the osmotic pressure.

(a) Define reverse osmosis. Name one SPM which can be used in the process of reverse osmosis.
(b) What do you expect to happen when red blood corpuscles (RBC's) are placed in 0.5% NaCl solution ?

Or

Which one of the following will have higher osmotic pressure in 1 M KCl or 1 M urea solution. Justify your answer
(c) Why osmotic pressure is a colligative property ?

5 Marks

1. Answer the following questions:-
   a) Components of a binary mixture of two liquids A and B were separated by distillation. After some time separation of components stopped and the composition of the vapour phase became the same as that of the liquid phase. Both the components started coming in the distillate. Explain why this happened.
   b) Calculate (a) molality (b) molarity and (c) mole fraction of KI if the density of 20% (mass/mass) aqueous KI is 1.202 g/ml.
2. Answer the following questions:
   a) For a dilute solution containing 2.5 g of a non-volatile non-electrolyte solute in 100 g of water, the elevation in boiling point at 1 atm pressure is 2C. Assuming concentration of solute is much lower than the concentration of solvent, determine the vapor pressure (mm of Hg) of the solution. [Given: b K for water = 1 0.76Kkgmol]
   b) Calculate the osmotic pressure in pascals exerted by a solution prepared by dissolving 1.0g of polymer of molar mass 185000 in 450 mL of water at 37C.

3. Answer the following:
   a) What role does molecular interaction play in the solution of alcohol in water?
   b) State Henry's law and mention some of its important applications.

Two Marks Questions Hint

1. **Hint:** Think about what changes with temperature for each type of concentration. Which units involve volume, and which involve only mass?
2. **Hint:** Henry's Law relates the partial pressure of a gas to its solubility. How does K_H appear in that relationship? What does a larger or smaller K_H value tell you about solubility?
3. **Hint:** (i) For any solution, osmotic pressure is given by $\pi = (w/MV) \times RT$; w= weight of the solute, V= volume of solution, R = gas constant and T is temperature

   i- For two solutions to be isotonic, $\pi 1 = \pi 2$ [0.5]
   $\Rightarrow 20/M1 = 40/M2$
   $\Rightarrow M1/M2 = 1/2$ [0.5]

   ii) Yes, Because at different temperatures the solutions are no longer isotonic and hence there will be movement of particles through osmosis.
4. The ratio of molar mass A:B:
   Let the molar mass of A is M_A and B is M_B
   Since the solutions are isotonic, so $C_1RT = C_2RT$ (equal osmotic pressure) [1 mark]
   $\Rightarrow 5/M_A + 1/M_B = 3/M_A + 5/M_B$
   $\Rightarrow 2/M_A = 4/M_B$
   $\Rightarrow M_A/M_B = 1/2$ [1 mark]

5. **Hint:** State the law precisely (relationship between partial pressure and mole fraction). For temperature effect, consider how kinetic energy of gas molecules changes with temperature and how that affects their ability to stay dissolved.
6. **Hint:** This is a direct application of Henry's Law. Assume the amount of dissolved gas is proportional to its partial pressure. Set up a ratio.
7. **Hint:** Use Raoult's Law for relative lowering of vapor pressure: $(\Delta P/P0)=X_{solute}$. You'll need to calculate moles of water first.
8. **Hint:** Use the osmotic pressure formula: $\Pi=iCRT$. Remember to convert temperature to Kelvin and ensure R has appropriate units.
9. **Hint:** Use the dilution formula: $M1V1=M2V2$. Calculate the final volume (V2) and then subtract the initial volume (V1) to find the added water.
10. **Hint:** Draw a phase diagram showing the vapor pressure curves for pure solvent and solution. The freezing point depression will be evident from the shift in the solid-liquid equilibrium line. Label axes clearly.

Three Marks Question Hint

1. **Hint:** Relate this to the solubility of gases (specifically oxygen) in liquids. How does temperature affect gas solubility?
2. **Hint:** Abnormal molecular weights arise due to association or dissociation of solute particles. Define Van't Hoff factor (i) and explain how it affects the number of particles in solution, thereby influencing colligative properties. Provide an example for each (e.g., NaCl dissociation, acetic acid association in benzene).
3. **Hint:** Calculate the elevation in boiling point (ΔTb). Then use the formula $\Delta Tb=Kb\times m$, where 'm' is molality. From molality, you can find the moles of solute and then molar mass.

4. **Hint:** This question seems incomplete as it only provides constants. It likely expects a calculation of freezing point depression or a related quantity if a concentration or mass of NaCl was given. If it's just stating facts, then just acknowledge them. *Self-correction: Assuming it implicitly asks for something like "Calculate the freezing point depression for a given concentration of NaCl." If no concentration is given, the question is incomplete.*
5. **Hint:** Use Henry's Law: Pgas=KH×Xgas. Calculate the mole fraction of N_2. Then, knowing the volume of water, calculate moles of water, and from mole fraction, find moles of N_2. Convert to millimoles.
6. **Hint:** First, use the freezing point depression (ΔTf) to find the molality of the solution: ΔTf=Kf×m. Since ethylene glycol is non-ionic, i=1. Once you have the molality, use it to calculate the elevation in boiling point (ΔTb=Kb×m) and then the new boiling point.
7. **Hint:** First, calculate the *expected* molality of benzoic acid. Then, calculate the *observed* molality using the freezing point depression formula (ΔTf=Kf×mobserved, you'll need Kf for benzene which is a common value, approx 5.12 K kg mol^{-1} - *Self-correction: If not provided, state that you assume this value or it's missing.*). The Van't Hoff factor i=mobserved/mexpected. If i < 1, it's association. If i > 1, it's dissociation.
8. **Hint:** Assume 100 g of solution. This means 15 g of solute and 85 g of solvent. Use these to find molality. For molarity, use density to find the volume of 100 g of solution, and then use moles of solute.
9. **Hint:** A 25% reduction means Ps=0.75P0. Use Raoult's Law: (P0−Ps)/P0=Xurea. Solve for Xurea. Then, knowing moles of water, calculate moles of urea and then mass of urea. Finally, calculate molality.
10. **Hint:** The question is incomplete because it's missing the concentration 'm' (molality or molarity?) of the aqueous solution. Assuming 'm' represents molality, if the question meant a specific molality (e.g., 0.1 m), then you would use that. Without a given concentration, it's impossible to calculate the mass of the solution. *Self-correction: Clarify that the question is incomplete without the concentration.*
11. **Hint:** i). Force of attraction decreases between solvent and solution as aresult volume increases (positive deviation). ii) temperature decreases c) examples
12. Vant Hoff factor of acetic acid in water:
    - Acetic acid in water dissociates to: $CH_3COOH + H_20 \text{--->} CH_3COO^- + H_30^+$ [1 mark]

i = 1 + α (n-1) [Where α =1 for 100 percent dissociation; n is no. of ions in the product]

=> i = 2 (in water) [1 mark]

Vant Hoff factor of acetic acid in Benzene: Acetic acid in Benzene associates to:
$2[CH_3COOH] > [CH_3COOH]_2$ [1 mark]
For association, i is given by i = 1 + α ((1/n)-1) [here n is no. of moles in the reactant]
=> i = 0.5 (in benzene) [1 mark]

(ii) Urea is an organic molecule having covalent bonds. It does not split into ions in the presence of a solvent.

CBQ (Case Based Questions)

Case Study 1

Q1.Hint: Look at the graph. How does solubility change with temperature *before* 34°C and *after* 34°C? Remember, endothermic processes usually increase solubility with temperature, and exothermic processes decrease it.
Q2.Hint: This is a hydrated salt, a specific chemical compound. Is it a solution in the typical sense of a mixture? Consider its fixed composition.
Hint: If Xwater=0.85, then XH2SO4=1−0.85. Assume a total of 1 mole of solution to find moles of water and H_2SO_4. Then use mass of water to calculate molality.
Q3. Hint: Think about the factors affecting solid solubility in liquids. Pressure significantly affects gas solubility, but does it have a similar effect on solids?
Q4. Hint: Dissociation

Case Study 2

Q1. Hint: The definition of colligative properties. What do they depend on?
Q2. Hint (for K_2SO_4): Write the dissociation equation and count ions.
Hint (for 40% dissociation): Use the formula for degree of dissociation: $i=1+\alpha(n-1)$, where α is the degree of dissociation and 'n' is the number of ions produced per molecule (assuming A*B- produces 2 ions, A+ and B−).
Q3. Hint: Write the dissociation equation for this complex salt. Count the total number of ions produced per formula unit.
Q4. Hint : Dissociation

Case study 3

Hint for all parts: First, calculate the moles of glucose and moles of water. Then you can calculate molality, mole fraction, ΔT_b, and ΔT_f.

- Molar mass of glucose ($C_6H_{12}O_6$) = 180 g/mol
- Molar mass of water (H_2O) = 18 g/mol

Q(i) Molality of the given solution is:

- **Hint:** Molality = (moles of solute) / (kg of solvent).

Q(ii) Boiling point for the solution will be:

- **Hint:** $\Delta Tb=Kb\times m$. New B.P. = Pure B.P. + ΔTb. Remember pure water boils at 373.15 K (100°C).
- **The depression in freezing point of solution will be:**
- **Hint:** $\Delta Tf=Kf\times m$.

Q(iii) Mole fraction of glucose in the given solution is:

- **Hint:** Xglucose=(moles of glucose)/(moles of glucose+moles of water).

Q(iv). Hint: Think in which direction osmosis takes place.

5 Marks

1. **Answer the following questions:-**
   a) Hint: This describes the formation of an azeotrope. Explain what an azeotrope is and why its components cannot be separated by simple distillation.
   b) Hint: The density value is missing. Assume a density (e.g., 1.20 g/mL) or state that it's missing. Then, assume 100g of solution. This means 20g KI and 80g water. Calculate moles of KI and water. Use density to find the volume of 100g solution for molarity.
2. **Answer the following questions:**
   a) Hint: The given Kb value seems unusual (10.76 K kg mol^{-1}?). The standard Kb for water is 0.52 K kg mol^{-1}. *Self-correction: Use the given Kb but note its unusual value if it's not a typo.*
   First, use ΔTb and Kb to find the molality (moles of solute). Then, use Raoult's Law of relative lowering of vapor pressure. You'll need the vapor pressure of pure water at the boiling point of the solution (which is 100°C + ΔTb). At 100°C, Pwater0 is 760 mm Hg.
   b) Hint: Use the osmotic pressure formula: $\Pi=CRT$. Calculate molarity (C) from mass and molar mass of polymer and volume of solution (assume 450 mL solution since it's a dilute polymer solution). Convert temperature to Kelvin and ensure R is in appropriate units (8.314 J mol^{-1} K^{-1} or 0.0821 L atm mol^{-1} K^{-1} - convert to Pascals).
3. **Answer the following:**
   a) Hint: Consider the types of intermolecular forces present (hydrogen bonding). Alcohol and water can both form hydrogen bonds. Explain how these interactions affect the solution's behavior (e.g., ideal vs. non-ideal, positive/negative deviation from Raoult's law).
   b) Hint: Restate the law clearly. Think about real-world scenarios where gas solubility in liquids is important or manipulated: carbonated drinks, deep-sea diving (bends), and the functioning of the lungs.

CHAPTER: ELECTROCHEMISTRY

MULTIPLE CHOICE QUESTIONS

1.	In the electrolysis of aqueous NaCl solution when Pt electrode is taken ,then which gas is librated at cathode? (a)H_2 (b)Cl_2 (c)O_2 (d) none of the above.
2.	Which is not true for a standard hydrogen electrode? (a)the hydrogen ion concentration is 1 M (b) Temperature is 25°C (c)Pressure of hydrogen is 1 atmosphere (d) It contains a metallic conductor which does not adsorb hydrogen
3.	The highest electrical conductivity of the following aqueous solutions is of : (a)0.1 M acetic acid (b) 0.1M chloroacetic acid (c)0.1M fluoroacetic acid (d) 0.1M di fluoroacetic acid
4.	The highest electrical conductivity of the following aqueous solutions is of : (a)0.1 M acetic acid (b) 0.1M chloroacetic acid (c)0.1M fluoroacetic acid (d) 0.1M di fluoroacetic acid
5.	On electrolysis of dilute sulphuric acid using platinum electrodes, the product obtained at anode will be ? (a)hydrogen (b) sulphur dioxide (c)hydrogen sulphide (d) oxygen
6	The standard reduction potentials of X, Y, Z metals are 0.52V, -3.03V, - 1.18V respectively. The order of reducing power of the corresponding metals is: (a) Y > Z > X (b) X > Y > Z (c) Z > Y > X (d) Z > X > Y
7.	Which of the following is a non-spontaneous cell reaction? (a) $Zn(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$ (b) $2Ag^{+}(aq) + Cu(s) \rightarrow 2Ag(s) + Cu^{2+}(aq)$ (c)$Fe(s) + Cu^{2+}(aq) \rightarrow Fe^{2+}(aq) + Cu(s)$ (d)$2H_2O(l) \rightarrow 2H_2(g) + O_2(g)$
8.	If M, N, O, P and Q are in the increasing order of their standard potentials in standard conditions of their standard half cells, then by combination of which two half cells maximum cell potential will be obtained? (a) M and N (b) M and O (c) M and P (d) M and Q
9	What happens to the cell potential (Ecell) as the concentration of reactants increases, according to the Nernst equation? (a) Increases (b) Decreases (c) Remains constant (d) Cannot be determined
10	What is the overall cell reaction in a lead-acid battery during discharge? (a) $Pb(s) + H_2SO_4(aq) \rightarrow PbSO_4(s) + H_2(g)$ (b) $Pb(s) + 2H^{+}(aq) \rightarrow Pb^{2+}(aq) + H_2(g)$ (c) $PbO_2(s) + Pb(s) + 2SO_4^{2-}(aq) \rightarrow 2PbSO_4(s) + 2H_2O(l)$ (d) $PbO_2(s) + Pb(s) + 2H_2SO_4(aq) \rightarrow 2PbSO_4(s) + 2H_2O(l)$
11	There are two beakers 'A' and 'B' containing KCl and CH_3COOH solutions respectively. On adding water to beakers A and B, which of the following change in Λ_m of the solutions will be correct? A. It increases sharply in beaker A and slowly in beaker B B. It increases slowly in beaker A and sharply in beaker B C. It decreases in beaker A but no change in beaker B. D. There is no change in beaker A but it decreases slowly in beaker B.

12	Under which of the following conditions will the chemical reaction in an electrochemical cell will be spontaneous? A. E^0_{cell} = +ve, ΔG= +ve B. E^0_{cell} = −ve, Δ G= −ve C. E^0_{cell} = +ve, Δ G= −ve D. E^0_{Cell} = −ve, ΔG= +ve
13	How much electricity in Faraday is required for the complete reduction of MnO_4 ions present in 500 ml of 0.5 M solution to Mn^{2+}? A. 5 F B.2.5 F C. 2.25 F D. 1.25 F

ASSERTION AND REASON TYPE QUESTIONS

In the following questions a statement of Assertion (A) followed by a statement of Reason (R) is given. Choose the correct answer out of the following choices.

(a)Both A and R are correct and R is the correct explanation of A.
(b)Both A and R are correct but R is not explain the A.
(c) Assertion (A) is correct but Reason (R) is incorrect.
(d) Assertion (A) is incorrect but Reason (R) is correct.

14. Assertion: An electrochemical cell can be set up only if the redox reaction is spontaneous.
Reason: A reaction is spontaneous if free energy change is negative.

15. Assertion: Identification of cathode and anode is done by the use of a thermometer.
Reason: Higher is the value of reduction potential, greater would be its reducing power.

16. Assertion: Molar conductivity increases, if concentration of weak electrolytic solution decreases.
Reason: On decreasing concentration of weak electrolytic solution, total number of ions increases due to increase of degree of ionisation.

17. Assertion: 2 F of charge is required to deposit 1 mol of silver at cathode during electrolysis of AgNO3 solution.
Reason: 1 mol of electron carries 1 F of charge.

18. Assertion : In the electrolysis of aqueous NaCl, hydrogen is liberated at the cathode instead of sodium.
Reason : Sodium has a more negative reduction potential than hydrogen.

SHORT ANSWER QUESTIONS (2 MARKS)

15. How much time does it require to reduce 3 moles of iron (III) to 3 moles of iron (II) ion by passing a 2.0 amp current?

16. Calculate the emf of the cell in which the following reaction takes place:
$Ni(s) + 2Ag^+$ (0.002 M) → Ni^{2+} (0.160 M) + 2Ag(s) [Given that E^o cell = 1.05 V,
log 2 = 0.301]

17. The electrolytic conductivity of $BaCl_2$ solution is 0.580 Sm^{-1} . Find out molar concentration of the solution if molar conductivity of this solution is $2.416 x 10^{-2}$ Sm^2 /mol.

18. A cell is prepared by dipping a zinc rod in 1M zinc sulphate solution and a silver electrode in 1M silver nitrate solution. The standard electrode potential given: E^0 Zn^{2+} / Zn =- 0.76 V, $E^0 Ag^+$ /Ag =+0.80 V What is the effect of increase in concentration of Zn^{2+} on the E cell?

19. The molar conductivity of a dilute solution of methanoic acid is 46.1 S cm^2 /mol. Calculate its degree of dissociation. (Given λ^0 (H+) = 349.6 S cm^2 /mol and λ^0 (HCOO$^-$) = 54.6 S cm^2 /mol)

20. Conductivity of 0.00241M acetic acid is 7.896 × 10^{-5} S cm^{-1}. Calculate its molar conductivity and if Λ^om for acetic acid are 390.5 S cm^2 mol^{-1}, what is its dissociation constant?

21. Given is an electrochemical cell;

$Mg/Mg^{2+}{}_{(aq)} \ || \ Cu^{2+}{}_{(aq)}/Cu_{(s)}$

Calculate the equilibrium constant of the cell at 25°C when the emf of the cell is zero.
(E^0 Mg^{2+} /Mg= -2.37V, Cu^{2+} /Cu= 0.34V, 2.303RT/F= 0.0591)

22. For an experiment, Aman prepared a 1-litre FeSO$_4$ solution of 1 M concentration and stored the solution in a glass jar. Before starting the experiment, Aman wants to stir the solution. Which of the following spoons should he use for this purpose and why?
Aluminium spoon (Al^{3+} /Al = -1.66V)
Copper spoon (Cu^{2+} /Cu = 0.34V)
(Given: E^0 /V Fe^{2+} /Fe = -0.44V)

23. What is the standard free energy change for the following reaction at room temperature? Is the reaction spontaneous?
$Sn\ (s) + 2Cu^{2+}\ (aq) \rightarrow Sn^{2+}\ (aq) + 2Cu^+\ (s)$

24. In a Standard Hydrogen Electrode (SHE), the platinum wire is normally dipped in 1 M con. HCl solution. Find out the potential of SHE if the platinum wire is dipped in a solution containing 1 x 10^{-10} M H$^+$ concentration.

25. i) Write down the complete cell reactions taking place at anode and cathode in a zinc/carbon dry cell.
ii) Is the above given cell a primary cell or a secondary cell? Explain.

26. A rusted piece of iron undergoes electrochemical reactions. Write the chemical reactions taking place at the following spots of that rusting piece of iron:

- i) At the spot that behaves as an anode
- ii) At the spot that behaves as a cathode
- iii) The overall balanced chemical reaction
- iv) Further oxidation of ferrous ion into rust

27. Predict the feasibility of the following reaction. Justify your answer.

Ag(s) + Fe^{3+} ------> Ag$^+_{(aq)}$+ Fe$_{(s)}$

(Given: *Ag$^+$ /Ag = 0.80V, Fe^{3+}/Fe = 0.77V*)

28. One Faraday of electric charge is passed through the electrolytic cells placed in a series containing solution of Ag$^+$, Cu^{2+}and Al^{3+}respectively.Find out the simple mass ratio of the metals deposited at the respective electrodes.
(Given - Atomic mass Ag=108g, Cu=63.5g. Al=27g)

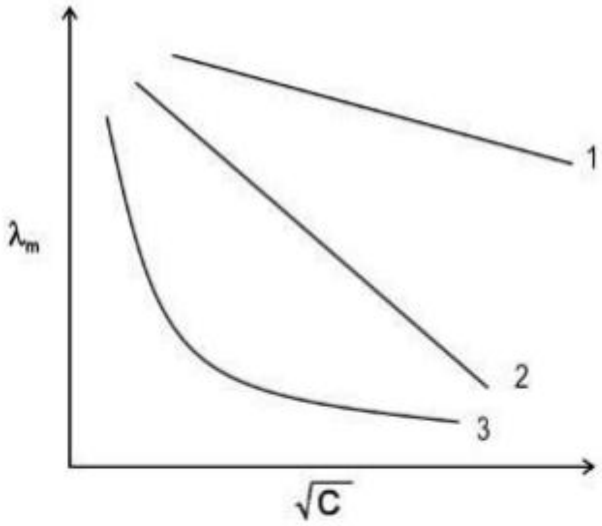
SHORT ANSWER QUESTIONS (3 MARKS)

29. (a) Why does the conductivity of a solution decrease with dilution?
(b) What is the effect of catalyst on:
(i) Gibbs energy (ΔG) and
(ii) activation energy of a reaction?

30. Represent the cell in which the following reaction takes place. The value of E^0 for the cell is 1.260 V. What is the value of E cell?
$2Al(s) + 3Cd^{2+}$ (0.1M) ------>$3Cd(s) + 2A1^{3+}$ (0.01M)

31. The molar conductivity of 0.025 mol L^{-1} methanoic acid is 46.1 S cm^2 mol^{-1} . Calculate its degree of dissociation and dissociation constant Given $\lambda°$ (H^+) =349.6 S cm^2 mol^{-1} and λ ° (HCOO-) = 54.6 S cm^2 mol^{-1}

32. (i) The molar conductivity vs √c curve for NaCl, HCl, and NH4OH are shown below in random order.



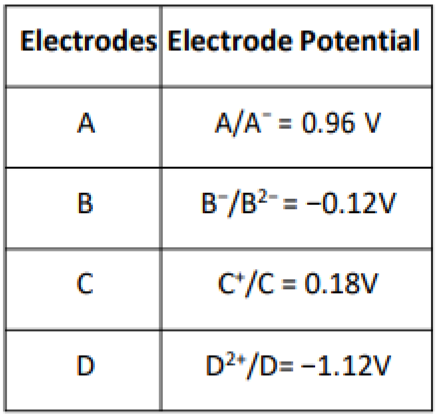
(i) Identify which graph corresponds to HCl, NaCl, and NH4OH.
(ii) Give reasons to justify your answer in (i).

33. Three electrolytic cells a, b, c containing solutions of $ZnSO_4$, $AgNO_3$ and $CuSO_4$, respectively are connected in series. A steady current of 1.5 amperes was passed through them until 1.45 g of silver deposited at the cathode of cell b. How long did the current flow? What mass of copper and zinc were deposited?

34. Calculate the emf of the following cell at 298 K
$Al(s)|Al^{3+}$ (0.15M) $|Cu^{2+}$ (0.025M)$|Cu(s)$
(Given: $E(A1^{3+}/A1)$= - 1.66V, $E(Cu^{2+}/cu)$=0.34V Log 0.15 = - 0. 8239, log 0.025 – 1.6020)

35. The resistance of a conductivity cell, when filled with 0.05M solution of an electrolyte x, is 100 Ω at 40 °C. The same conductivity cell filled with 0.01 M solution of electrolyte y, has a resistance of 50 Ω. The conductivity of 0.05 M solution of electrolyte x is 1.0×10^{-4} S cm^{-1} calculate :
(i) Cell constant
(ii) Conductivity of y solution.
(iii) Molar conductivity of 0.01M y solution.

36. There are four electrodes A, B, C, and D. E 0 values of the electrodes are as follows.



Electrodes	Electrode Potential
A	$A/A^- = 0.96$ V
B	$B^-/B^{2-} = -0.12$V
C	$C^+/C = 0.18$V
D	$D^{2+}/D= -1.12$V

The combination of which of two electrodes will give the largest cell potential? Justify your answer. Also, find the emf of the cell.

37. The Gibbs energy change for the reduction of Al_2O_3 at 500°c is given as:
2/3 Al_2O_3 ----- > 4/3 Al_3 + O_2; $\Delta G = +960$KJ
Calculate the minimum potential difference required to reduce 2/3 mole of Al_2O_3 at 500°C. (1F = 96500C)

38. In an experiment, the electrolysis of copper sulphate solution takes place under the following conditions-
- Electrolysis time (t) = 10 min.
- Current passed (I) = 1.5 amp.

What mass of copper will be deposited at the cathode in this experiment?
(Note: atomic mass Cu= 63.5g; For calculation use 1 Faraday = 96500 Coulombs.)

39. Imagine you are in a chemistry lab and the teacher is explaining the electrolysis of $CuSO_4$ solution and the products liberated after electrolysis. The teacher made two Setups for the electrolysis process. In Set up-i electrolysis of $CuSO_4$ solution is done by using Pt electrodes and in Set up-II electrolysis of $CuSO_4$ solution is done by using Cu electrodes. Answer the following questions based on this:

i) In which Set up I or II will the colour of $CuSO_4$ solution fades away and why?

ii) Write the chemical reaction taking place at the Cu anode in Set up II.

iii) Name the product obtained at the anode in Set up I.

iv) Which out of Set up I or II depict refining of crude copper?

COMPETENCY BASED QUESTIONS

40. Rahul set-up an experiment to find resistance of aqueous KCl solution for different concentrations at 298 K using a conductivity cell connected to a Wheatstone bridge. He fed the Wheatstone bridge with a.c. power in the audio frequency range 550 to 5000 cycles per second. Once the resistance was calculated from null point he also calculated the conductivity K and molar conductivity Λm and recorded his readings in tabular form.

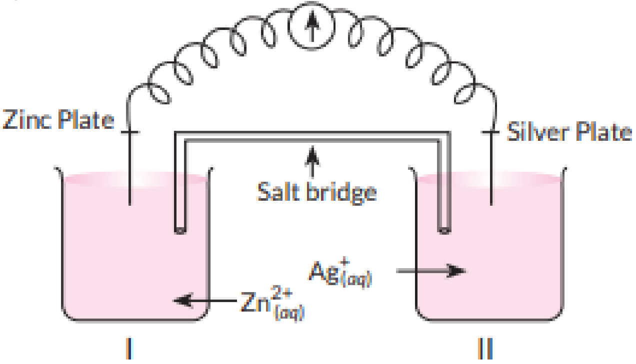
S.NO.	Conc.(M)	K S cm^{-1}	Λm S $cm^2 mol^{-1}$
1	1.00	111.3×10^{-3}	111.3
2	0.10	12.9×10^{-3}	129.0
3	0.01	1.41×10^{-3}	141.0

Answer the following questions :
(a) Why does conductivity decrease with dilution ?

(b) If Λm^0 of KCl is 150.0 S $cm^2 mol^{-1}$, calculate the degree of dissociation of 0.01MKCl.
(c) If Rahul had used HCl instead to KCl then would you expect the Λm values to be more or less than those per KCl for a given concentration. Justify.

41. Read the passage given below and answer the questions that follow :

Oxidation-reduction reactions are commonly known as redox reactions. They involve transfer of electrons from one species to another. In a spontaneous reaction, energy is released which can be used to do useful work. The reaction is split into two half reactions. Two different containers are used and a wire is used to drive the electrons from one side to the other and a voltaic/galvanic cell is created. It is an electrochemical cell that uses spontaneous redox reactions to generate electricity. A salt bridge also connects to the half cells. The reading of the voltmeter gives the cell voltage or cell potential or electromotive force. If E° cell is positive the reaction is spontaneous and if it is negative the reaction is non-spontaneous and is referred to as electrolytic cell. Electrolysis refers to the decomposition of a substance by an electric current. One mole of electric charge when passed through a cell will discharge half a mole of a divalent metal ion such as Cu2+. This was first formulated by Faraday in the form of laws of electrolysis. The conductance of material is the property of materials due to which a material allows the flow of ions through itself and thus conducts electricity. Conductivity is represented by k and it depends upon nature and concentration of electrolyte, temperature etc. A more common term molar conductivity of a solution at a given concentration is conductance of the volume of solution containing one mole of electrolyte kept between two electrodes with the unit area of cross-section and distance of unit length. Limiting molar conductivity of weak electrolytes cannot be obtained graphically.



(a) Is silver plate the anode or cathode ?
(b) What will happen if the salt bridge is removed ?
(c) When does electrochemical cell behave like an electrolytic cell ?
(d) (i) What will happen to the concentration of Zn^{2+} and Ag^+ when Ecell = 0.
(ii) Why does conductivity of a solution decreases with dilution ?

OR

(d) The molar conductivity of a 1.5 M solution of an electrolyte is found to be 138.9 S $cm^2 mol^{-1}$. Calculate the conductivity of this solution.

42. A famous book of Paulo Coehlo The Alchemist was best seller of his time. Alchemistry in olden days was defined as study metals and their properties. All the efforts were concentrated largely to convert cheaper metals like iron etc into precious metals like gold. These efforts however could not convert cheaper metals into gold but new theories in field of chemistry led us to todays technique of electroplating. Now a days we can plate precious metals like gold and platinum on cheaper metals and can enjoy artificial jewellery which shines like real one. Faraday's laws of electrolysis helped us to make use of electrolysis for purification of metals and plating of a desired metal on to the other. Faraday's laws are actually not new to mankind as similar techniques were known to ancient Indians also and were in use as reported in many of our literature like Visheshika Sutras as written by Rishi Kannad.

(i) Predict the product of electrolysis when an aqueous solution of $AgNO_3$ is electrolysed with silver electrodes.

(ii) How will you determine the limiting molar conductivity of water?

(iii) If a current of 2.0 ampere flows through a metallic wire for 3 hours, then how many electrons would flow through the wire?

43. In a galvanic cell, chemical energy of a redox reaction is converted into electrical energy, whereas in an electrolytic cell the redox reaction occurs on passing electricity. The simplest galvanic cell is in which Zn rod is placed in a solution of ZnSO, and Cu rod is placed in a solution of CuSO The two rods are connected by a metallic wire through a voltmeter. The two solutions are joined by a salt bridge. The difference between the two electrode potentials of the two electrodes is known as electromotive force.

In the process of electrolysis, the decomposition of a substance takes place by passing an electric current. One mole of electric charge when passed through a cell will discharge half a mole of a divalent metal ion such as Cu^{2+}• This was first formulated by Faraday in the form of laws of electrolysis.

Answer the following questions :

(a) What is the function of a salt bridge in a galvanic cell ?

(b) When does galvanic cell behave like an electrolytic cell ?

(c) Can copper sulphate solution be stored in a pot made of zinc ?

Explain with the help of the value of E° cell.

(E° Cuz+ / Cu = 0.34 V)

E° Zn^{2+} / Zn = - 0.76 V)

44. Batteries and fuel cells are very useful forms of galvanic cell. Any battery or cell that we use as a source of electrical energy is basically a galvanic cell. However, for a battery to be of practical use it should be reasonably light, compact and its voltage should not vary appreciably during its use. There are mainly two types of batteries primary batteries and secondary batteries. In the primary batteries, the reaction occurs only once and after use over a period of time the battery becomes dead and cannot be reused again, whereas the secondary batteries are rechargeable. Production of electricity by thermal plants is not a very efficient method and is a major source of pollution. To solve this problem, galvanic cells are designed in such a way that energy of combustion of fuels is directly converted into electrical energy, and these are known as fuel cells. One such fuel cell was used in the Apollo space programme.

Answer the following questions :

(a) How do primary batteries differ from secondary batteries ? 1

(b) The cell potential of Mercury cell is 1·35 V, and remains constant during its life. Give reason. 1

(c) Write the reactions involved in the recharging of the lead storage battery. 2

OR

(c) Write two advantages of fuel cells over other galvanic cells. 2

45. Rahul set-up an experiment to find resistance of aqueous KC*l* solution for different concentrations at 298 K using a conductivity cell connected to a Wheatstone bridge. He fed the Wheatstone bridge with a.c. power in the audio frequency range 550 to 5000 cycles per second. Once the resistance was calculated from null point he also calculated the conductivity K and molar conductivity $\wedge_m$ and recorded his readings in tabular form. Answer the following questions :-

S. NO.	**Conc.(M)**	**k S cm^{-1}**	**$\wedge_m$ S cm^2 mol^{-1}**
1	1.00	111.3×10^{-3}	111.3
2	0.10	12.9×10^{-3}	129.0
3	0.01	1.41×10^{-3}	141.0

(a) Why does conductivity decrease with dilution ?

(b) If $\wedge_m^o$ of KC*l* is 150.0 S cm^2 mol^{-1}, calculate the degree of dissociationof 0.01 M KC*l*. **1**

(c) If Rahul had used HC*l* instead to KC*l* then would you expect the $\wedge_m$ values to be more or less than those per KC*l* for a given concentration. Justify.

OR

(c) Amit, a classmate of Rahul repeated the same experiment with CH3COOH solution instead of KC*l* solution. Give one point that would be similar and one that would be different in his observations as compared to Rahul.

LONG ANSWER QUESTIONS

46. (a) Calculate the charge required in coulombs to reduce 0.5 moles of Cr_2O_7 ion to Cr in acid solution. (1 Faraday = 96500C)
b) Three electrolytic cells A, B, C containing solutions of $ZnSO_4$, $AgNO_3$ and $CuSO_4$ respectively are connected in series. A steady current of 1.5 ampere was passed through them until 1.45 g of silver deposited at the cathode of cell B. How long did the current flow? What mass of copper & zinc were deposited?

47. A current was passed for 5 hours through two electrolytic cells connected in series. The first cell contains $AuCl_3$ and second cell $CuSO_4$ solution. If 9.85 g of gold was deposited in the first cell, what amount of copper gets deposited in the second cell? Also calculate magnitude of current in ampere. Given: Atomic mass of Au = 197 amu and Cu = 63.5 amu.

48. (i) One Faraday of electric charge is passed through the electrolytic cells placed in a series containing solution of Ag^+ , Cu^{2+} and Al^{3+} respectively. Find out the simple mass ratio of the metals deposited at the respective electrodes.
(Given - Atomic mass Ag=108g, Cu=63.5g. Al=27g)
ii) In a galvanic cell when the potential difference becomes zero, the cell is said to be in an equilibrium state. Establish the relation between E^0 and equilibrium constant at 298 k in a Daniell cell. The E^0 value of the Daniell cell is 1.10V.
(R= 8.314 j/k/mol, F = 96500 C)

49. a) Calculate the standard Gibbs energy (AG) of the following reaction at 25 °C :
$Au(s) + Ca^{2+} (1M) \rightarrow Au^{3+} (1M) + Ca(s)$
$Au^{3+} /Au = + 1.5$ V, E $Ca^{2+} /Ca = - 2.87$ V
Predict whether the reaction will be spontaneous or not at 25 °C.
[1 F = 96500 C mol-'
b) Tarnished silver contains Ag_2S. Can this tarnish be removed by placing tarnished silverware in an aluminium pan containing an inert electrolytic solution such as NaCl?
The standard electrode potential for half reaction:
$Ag_2S(s) + 2e- - > 2Ag(s) + S^{2-}$ is -0.71 V and for
$Al^{3+} + 3e.$ ….. $> 2Al (s)$ is -1.66 V

ANSWER KEY
CHAPTER: ELECTROCHEMISTRY

1. (a)H2
2. (d) It contains a metallic conductor which does not adsorb hydrogen
3. (d) 0.1M di fluoroacetic acid
4. (c)H2,Br2 and NaOH
5. (d) oxygen
6. (a) Y > Z > X
7. (d)$2H_2O(l) \rightarrow 2H_2(g) + O_2(g)$
8. (d) M and Q
9. (b) Decreases
10. (d) $PbO_2(s) + Pb(s) + 2H_2SO_4(aq) \rightarrow 2PbSO_4(s) + 2H_2O(l)$
11. (B)
12. (C)
13. (D)
14. (a)Both A and R are correct and R is the correct explanation of A.
15. (d) Assertion (A) is incorrect but Reason (R) is correct.

16. (a)Both A and R are correct and R is the correct explanation of A.
17. (d) Assertion (A) is incorrect but Reason (R) is correct.
18. (a)Both A and R are correct and R is the correct explanation of A.
19. Ans. t = 144750 s Hint: charge required is = 3 F
20. 0.91 V
21. C= 0.0240 mol/L Hint: Λm = k/C

22. As per Nernst equation if [Zn2+] increased, Ecell will be decreased.
23. Degree of dissociation = 0.114 Hint: $\alpha = \Lambda m / \Lambda m^0$
24. $Ka=1.85*10^{-5}$Mol/L
25. $Kc=5.116x10^{91}$ Hint: take antilog $n.x=0.x\ x10^n$
26. -Aman should use the Copper spoon.

Hint:Cu2++2e- ----> Cu(s)

-Moreover, Cu here is in the solid state. Hence Cu spoon can be used to stir the solution as it will not bring any change in the FeSO4 solution.

27. -55970 J/mol Hint: $\Delta G^o = -nFE^o$ cell

28. E=0.59V (log 10 = 1)

29. In a Zinc/Carbon dry cell complete cell reaction is:

Zn(s) + 2MnO2(s) +2 $NH4^{+}$ (aq) -->Zn^{2+} (aq) +Mn2O3(s) + 2NH3(aq) +H2O(l)

or

Zn(s) + MnO2(s) + $NH4^{+}$ ---> $Zn^{2+(}$aq)+MnO(OH)(s) +NH^3 (aq)

The Zinc/Carbon dry cell is a primary cell.

- A primary cell is one in which redox reaction cannot be reversed. The Zinc/Carbon cell becomes dead after a long time of use i.e.it stops working. This shows it is a primary cell.

30. Chemical reactions are as follows:

At anode: Fe(s) ---> Fe^{2+} (aq) $+2e^-$
At cathode: O2 (g) $+4H^+$ (aq) $+4e^-$ --> 2H2O(l)
Over all reaction:

2Fe(s) +O2(g) $+4H^+_{(aq)}$ --> $2Fe^{2+}$ (aq)+$2H_2O_{(l)}$

Further oxidation :

$2Fe^{2+}$ $+2H_2O$ $+1/2O_2$ --> Fe_2 O_3 $+4H^+$

31. A chemical reaction is feasible if E^0_{cell} is positive i.e. if potential of the cell is positive. This reaction is not feasible as E^0_{cell} is negative

32. - Charge required for the Reduction of 1 mole of $Cr2O7^{2-}$ ion is $Cr2O7^{2-}$$+ 6e^- + H^+$---> $2Cr^{3+}$.

6 Faraday - Therefore, charge required for 0.5 mole ion is $Cr2O7^{2-}$ $+3e^- +H^+$--> Cr^{3+}

3 Farada i.e. 96500C x 3 = 289500C

(1 F= 96500C)

33. . Hint: (a) On dilution, the number of ions per unit volume decreases.
b) (i) no effect
(ii) The catalyst provides an alternative pathway

34. =1.269 V

35. 3.67×10^{-4}

36. (i) From the above graph,

1 corresponds to HCl
2 corresponds to NaCl

3 corresponds to NH_4OH

(ii) Hint - Strong electrolytes are already completely dissociated and there is a small increase (change) in dissociation on dilution.

37. 14.40 min
0.426 g of Cu
0.439 g of Zn

38. 1.9689 V

39. (i) Cell constant $=10^{-2}$ cm^{-1}

(ii) Conductivity of solution y = 2×10^{-4} S cm^{-1} (iii) Molar conductivity of solution y, $\Lambda m = 20$ S cm^2 mol^{-1}

40. A combination of electrodes A and D will give the largest cell potential.
=> emf of the cell = 2.08 V

41. minimum potential difference= 2.487V OR ≈ 2.5 V   Hint: $\Delta G = - n E F$

42. Amount of Cu at cathode = 0.296 g

43. In experimental Set up I, the blue colour of $CuSO_4$ solution will fade away. It is because $CuSO_4$ solution will turn into H_2SO_4 solution.

Oxidation of water leaves behind H^+ and reduction of Cu^{2+} ion leaves SO_4^{2-} ion in the solution.

$2H^+ + SO_4^{2}$ > H_2SO_4

Set up II depict the refining of Cu metal.

In this setup, an impure copper rod is made anode, where oxidation takes place, At anode and a pure thin wire of copper is made cathode. At cathode-

44. (a) Conductivity decreases with dilution because it depends upon the number of ions present in the solution. When dilution increases number of available ions decreases. Hence, conductivity decreases.
(b) Correct reason
(c) correct reason

45. At cathode : $2Ag^+ + 2e^- \rightarrow 2Ag$

So, silver plate is acting as cathode where reduction is taking place.
(b) Hint: If the salt bridge is removed voltage will drop to zero and no current will flow.
(c) Hint: direction of flow of current is reversed.
(d) (i) the concentrations of Zn2+ and Ag+ will become constant.
(ii) the number of ions per unit volume decreases with dilution.

OR

(d) 0.208 S cm^{-1}

46. (i) at cathode Ag will be deposited and at Cathode anode Ag+2 will pass into the solution.

(ii) By using Kohlrausch law

(iii) $n=1.3\times10^{23}$ electrons.   Hint: $Q= n\times1.6\times10^{-19}$

47. Answer

48. Answer

49. answer

50. (a) 289500 C

(b) t= 863s

deposits Cu =0.426 g

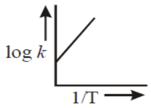
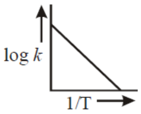
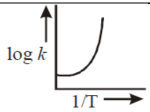
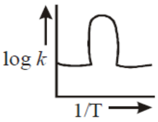
51. Amount of Cu deposited : 4.76g (Hint: Eq. wt. of Au 65.66 and Cu 31.75)
I= 0.8 ampere

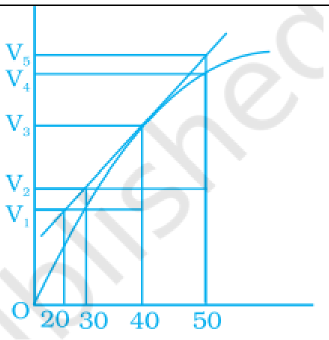
52. (i) 24:7:2
(ii) $K=1.7\times10^{37}$

53. Calculate free energy and predict spontaneity

CHEMICAL KINETICS

MCQ

1	The slope in Arrhenius plot, is equal to: (a) $-\dfrac{E_a}{2.303R}$ (b) $\dfrac{E_a}{R}$ (c) $-\dfrac{R}{2.303E_a}$ (d) None of these
2	The term – dx/dt in a rate equation refers to : (a) the conc. of a reactant (b) the decrease in conc. of the reactant with time (c) the velocity constant of reaction (d) None of these
3	Instantaneous rate of a chemical reaction is (a) rate of reaction in the beginning (b) rate of reaction at the end (c) rate of reaction at a given instant (d) rate of reaction between two specific time intervals
4	Order of reaction is decided by (a) temperature (b) mechanism of reaction as well as relative concentration of reactants (c) molecularity (d) pressure
5	A zero order reaction is one whose rate is independent of- (a) the concentration of the reactants (b) the temperature of reaction (c) the concentration of the product (d) the material of the vessel in which reaction is carried out
6	For the reaction $A + 2B \rightarrow C$, rate is given by $R = [A]\,[B]2$ then the order of the reaction is (a) 3 (b) 6 (c) 5 (d) 7
7	Which of the following influences the reaction rate performed in a solution? (a) Temperature (b) Activation energy (c) Catalyst (d) All of the above
8	A catalyst increases the reaction rate by: (a) decreasing enthalpy (b) increasing internal energy (c) decreasing activation enthalpy (d) increasing activation enthalpy
9	In a reaction, the threshold energy is equal to (a) activation energy + normal energy of reactants (b) activation energy - normal energy of reactants (c) normal energy of reactants - activation energy (d) average kinetic energy of molecules of reactants
10	A graph plotted between log k vs 1/T for calculating activation energy is shown by (a)  (b)  (c)  (d) 
11	A graph of volume of hydrogen released vs time for the reaction between zinc and dil.HCl is given in Fig. On the basis of this mark the correct option-

	(i) Average rate upto 40s is $\frac{V_3 - V_2}{40}$ (ii) Average rate upto 40 seconds is $\frac{V_3 - V_2}{40 - 30}$ (iii) Average rate upto 40 seconds is $\frac{V_3}{40}$ (iv) Average rate upto 40 seconds is $\frac{V_3 - V_1}{40 - 20}$ 
12	Consider the graph given in above Fig which of the following options does not show instantaneous rate of reaction at 40th second? (a) V_5-V_2/50-30 (b) V_4-V_2/50-30 (c) V_3-V_2/40-30 (d) V_3-V_1/40-20

Assertion Reason Questions

A statement of assertion is followed by a statement of reason. Mark the correct choice from the options given below:

(a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are true but reason is not the correct explanation of assertion.
(c) Assertion is true but reason is false.
(d) Assertion is false but reason is true.

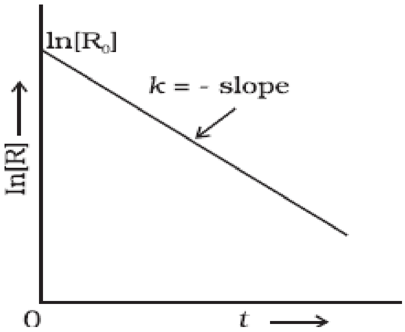
1. **Assertion** : Order of a reaction with respect to any reactant or product can be zero, positive, negative and fractional.
   Reason : Rate of a reaction cannot decrease with increase in concentration of a reactant or product.
2. **Assertion-** The rate of a reaction sometimes does not depend on concentration.
   Reason- Lower the activation energy faster is the reaction.
3. **Assertion** – Order and molecularity of a reaction is always same.
   Reason– Order is determined experimentally whereas molecularity by a balanced elementary reaction.
4. **Assertion** – In a first order reaction, if the concentration of the reactant is doubled, its. half-life is also doubled.
   Reason – Half-life of a reaction does not depend upon initial concentration of the reactant in a first order reaction.
5. **Assertion** – Average rate and instantaneous rate of a reaction has the same unit.
   Reason – Average rate becomes instantaneous rate when time interval is too small.

Ans: 1. (c) 2. (b) 3. (d) 4. (d) 5. (b)

Two Marks Questions

1. (a) How does catalyst alter rate of a reaction?
   (b) A reaction is 50% complete in 2 hours and 75% completes in 4 hours. What is the order of the reaction?
2. (a)What is the unit of rate constant for a Pseudo first order reaction?
   (b) What is the overall order of reaction which has the rate expression r= k $[A]^2[B]^0$?

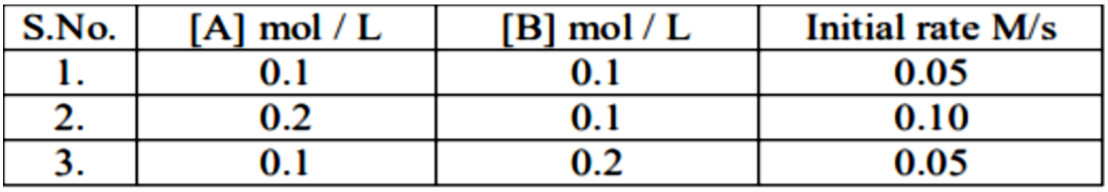
3. What is the effect of adding a catalyst on :
   (a) Activation energy (Ea) and (b) Gibbs energy (ΔG) of a reaction.
4. A first order reaction takes 30 minutes for 75% decomposition. Calculate $t_{1/2}$.
   Given : [log 2 = 0.3, log 3 = 0.48, log 4 = 0.6, log 5 = 0.7]
5. The decomposition of NH_3 on Pt surface is a zero order reaction. What are the rate of formations of N_2& H_2 if k= 2.5 x 10-4 mol $L^{-1}s^{-1}$.
6. What is the effect of temperature on the rate constant of a reaction?
7. Define each of the following:
   (i) Specific rate of a reaction. (ii) Energy of activation of a reaction.
8. The rate of the chemical reaction doubles for an increase of 10 K in absolute temperature from 298 K. Calculate Ea.
9. In a reaction, 2A → Products, the concentration of A decreases from 0.5 mol L^{-1} to 0.4 mol L^{-1} in 10 minutes. Calculate the rate during this interval?
10. (a) A graph is drawn between ln[R] and *t* for a reaction. What is order of reaction?



(b) For a reaction R→P, half-life (t½) is observed to be independent of the initial concentration of reactants. What is the order of reaction?

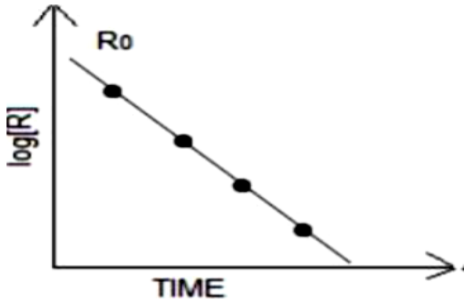
Three Marks Questions

a. A reaction is first order in A and second order in B.
   (i) Write the differential rate equation.
   (ii) How is the rate affected on increasing the concentration of B three times?
   (iii) How is the rate affected when the concentrations of both A and B are doubled?
b. A 1st order reaction is 40% complete in 50 minutes. Calculate the value of rate constant. At what time will the reaction be 80% completed?
c. In the given reaction A + 3B → 2 C, the rate of formation of C is 2.5 x 10^{-4} mol$L^{-1}s^{-1}$.
   Calculate the (i) rate of reaction (ii) rate of disappearance of B
d. Give three important differences between rate of reaction and rate constant of reaction.
e. Give four important differences between order of reaction molecularity of reaction.
f. For the reaction A + B →products, the following initial rates were obtained at various given initial concentrations. Determine the overall order of a reaction-



S.No.	[A] mol / L	[B] mol / L	Initial rate M/s
1.	0.1	0.1	0.05
2.	0.2	0.1	0.10
3.	0.1	0.2	0.05

g. Observe the graph in diagram and answer the following questions.



(i) If slope is equal to -2.0 x10-6 sec-1, what will be the value of rate constant?

(ii) How does the half-life of zero order reaction relate to its rate constant?

h. (a) Consider a certain reaction A → Products with k = 2.0 × 10-2 s-1. Calculate the concentration of a remaining after 100 s if the initial concentration of A is 1.0 mol l^{-1}

(b) The half-life for radioactive decay of C -14 is 5730 years. An archaeological artefact containing wood had only 80% of the C -14 found in a living tree. Estimate the age of the sample**.**

i. If a zero-order reaction starts with the concentration of 10 mol/L, it's half-life is 2 minutes, what will be the half-life of the same reaction, if it is started with 20 mol/L?

j. (i) What will be the effect of temperature on rate constant?

(ii) State a condition under which a biomolecular reaction is kinetically first order reaction.

(iii) For a zero-order reaction, will the molecularity be equal to zero? Explain.

CBQ

1. **Read given passage and answer the questions that follow:**

Chemical kinetics deals with rate of chemical reactions, how fast reactants get used up or how fast products are formed in the reaction. Different chemical reactions have different speed. Rate of reaction depends upon concentration of reactants, temperature, pressure especially in gaseous reactions and presence of catalyst. Chemical reaction takes place as a results of collision between reacting molecules. The rate of reaction does not depend upon total number of collisions rather it depends upon number of effective collisions. In a redox reaction, if E°cell is +ve, ΔG° will be –ve and 'K' equilibrium constant will be high i.e. products formed will be more than the reactants.

(a) What is meant by activation energy?

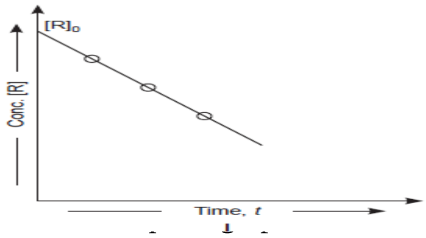
(*b*) What does $e^{-Ea/RT}$ represent?

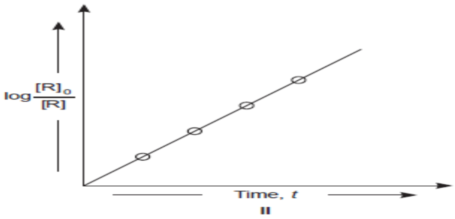
(*c*) If $Fe^{3+} + 2I^{-} \rightarrow Fe^{2+} + I_2$ has E° = 0.24V, what is the value of log K? What does value of 'K' indicate?

OR

What type of molecules undergo effective collisions?

2. Observe the following graphs and answer the questions based on these graphs.





(graph I?

(b

(*c*) How does $t_{1/2}$ varies with initial concentration in zero order reaction?

OR

If $t_{1/2}$ of first order reaction is 40 minute, what will be $t_{99.9\%}$ for first order reaction?

3. Read the passage carefully and answer the questions that follow Order of the Reaction

The rate law for a chemical reaction relates the reaction rate with the concentrations or partial pressures of the reactants. For a general reaction, aA + bB→ C with no intermediate steps in its reaction mechanism, meaning that it is an elementary reaction. The rate law is given by r = k $[A]^x$ [B]y where [A] and [B] express the concentrations of A and B in moles per litre. Exponents x and y vary for each reaction and are determined experimentally. The value of k varies with conditions that affect reaction rate, such as temperature, pressure, surface area, etc. The sum of these exponents is known as overall reaction order. A zero order reaction has constant rate that is independent of the concentration of the reactants. A first order reaction depends on the concentration of only reactant. A reaction is said to be of second order when the overall order is two. Once we have determined the order of the reaction, we can go back and plug one set of our initial values and solve for k.

Answer the following questions:

(a) Calculate the overall order of the reaction which has the following rate expression:

Rate= $k[A]^{1/2}[B]^{3/2}$

(b) What is the effect of temperature on rate of the reaction?

(c) What is meant by the rate of reaction?

(d) A first order reaction takes 77.78 minutes for 50% completion. Calculate the time required for 30% completion of the reaction. (log 10= 1, log 7=0.8450)

OR

A first order reaction has a rate constant $1x10^{-3}$ s^{-1}. How long will 5 gm of this reactant take to reduce to 3 gm? (log 3= 0.4771, log 5=0.6990)

4. Read the passage carefully and answer the questions that follow

Temperature Dependence of Rate of a Reaction

Temperature influences the rate of a reaction. As the temperature increases, the rate of a reaction increases. For example, the time taken to melt a metal will be much higher at a lower temperature but it will decrease as soon as we increase the temperature. It has been found that the rate constant is nearly *doubled* for a chemical reaction with a rise in temperature by 10°. The dependence of the rate of a chemical reaction on temperature can be explained by Arrhenius equation.

$k = A\ e^{-Ea/RT}$

According to the Arrhenius equation, a reaction can only take place when a molecule of one substance collides with the molecule of another to form an unstable intermediate. This intermediate exists for a very short time and then breaks up to form product. The energy required to form this intermediate is known as activation energy (Ea). The fraction of molecules with kinetic energy equal to or greater than Ea at a given temperature may lead to the product. As the temperature rises, the proportion of molecules with energies equal to or greater than activation energy (≥Ea) increases. As a result, the reaction rate would increase.

Answer the following questions:

(a) How does the half life period of a first order reaction vary with temperature?

OR

For an endothermic reaction, the activation energy of forward reaction will be equal to or less than or more than activation energy of backward reaction.

(b)The slope of Arrhenius Plot (ln k vs 1/T) of first order reaction is $-5\times10^3 K$. Calculate the value of *Ea* of the reaction. [Given R = $8.314 JK^{-1}\ mol^{-1}$]

(c) The rate constant of a reaction is 6×10^{-3} s^{-1} at 50° and 9×10^{-3} s^{-1} at 100° C. Calculate the energy of activation of the reaction.

5. Read the passage carefully and answer the questions that follow

Radio Activity

There are nuclear reactions constantly occurring in our bodies, but these are very few of them compared to the chemical reactions, and they do not affect our bodies much. All of the physical processes that take place to keep a human body running are chemical processes. Nuclear reactions can lead to chemical damage, which the body may notice and try to fix. The nuclear reaction occurring in our bodies is radioactive decay. This is the change of a less stable nucleus to a more stable nucleus. Every atom has either a stable nucleus or an unstable nucleus, depending on how big it is and on the ratio of protons to neutrons. The ratio of neutrons to protons in a stable nucleus is thus around 1:1 for small nuclei ($Z<20$). Nuclei with too many neutrons, too few neutrons, or that are simply too big are unstable. They eventually transform to a stable form through radioactive decay. Wherever there are atoms with unstable nuclei (radioactive atoms), there are nuclear reactions occurring naturally. The interesting thing is that there are small amounts of radioactive atoms everywhere: in your chair, in the ground, in the food you eat, and yes, in your body. The most common natural radioactive isotopes in humans are carbon-14 and potassium-40. Chemically, these isotopes behave exactly like stable carbon and potassium. For this reason, the body uses carbon-14 and potassium-40 just like it does normal carbon and potassium; building them into the different parts of the cells, without knowing that they are radioactive. In time, carbon-14 atoms decay to stable nitrogen atoms and potassium-40 atoms decay to stable calcium atoms. Half-life of C-14 is 6000 years Chemicals in the body that relied on having a carbon14 atom or potassium-40 atom in a certain spot will suddenly have a nitrogen or calcium atom. Such a change damages the chemical. Normally, such changes are so rare, that the body can repair the damage or filter away the damaged chemicals.

Answer the following questions:

(a) Why is Carbon -14 radioactive while Carbon -12 not?

(Atomic number of Carbon: 6)

(b) Which are the two most common radioactive decays happening in human body?

(c) Suppose an organism has 20 g of Carbon -14 at its time of death. Approximately how much Carbon -14 remains after 10,320 years? (Given antilog 0.517 = 3.289)

OR

(c) Approximately how old is a fossil with 12 g of Carbon -14 if it initially possessed 32 g of Carbon -14? (Given log 2.667 = 0.4260)

6. (a) Reactant ‘A’ underwent a decomposition reaction. The concentration of ‘A’ was measured periodically and recorded in the table given below :

Time/Hours	[A]/M
0	0.40
1	0.20
2	0.10
3	0.05

Based on the above data, predict the order of the reaction and write the expression for the rate law.

OR

The reaction between H_2 (g) and I_2 (g) was carried out in a sealed isothermal container. The rate law for the reaction was found to be : Rate = $k[H_2][I_2]$

If 1 mole of H_2 (g) was added to the reaction chamber and the temperature was kept constant, then predict the change in rate of the reaction and the rate constant.

7. The rate of reaction is concerned with decrease in concentration of reactants or increase in the concentration of products per unit time. It can be expressed as instantaneous rate at a particular instant of time and average rate over a large interval of time. Mathematical representation of rate of reaction is given by rate law. Rate constant and order of a reaction can be determined from rate law or its integrated rate equation.

(i) What is average rate of reaction ? 1
(ii) Write two factors that affect the rate of reaction. 1
(iii) (1) What happens to rate of reaction for zero order reaction ?
(2) What is the unit of k for zero order reaction ? 2 1=2

OR

(iii) (1) For a reaction P + 2Q Products Rate = k[P]1/2 [Q]1. What is the order of the reaction ?
(2) Define pseudo first order reaction with an example. 2 1=2

Five Marks Questions

1. (i) For the hydrolysis of methyl acetate in aqueous solution, the following results were obtained:

t/s	0	20	40
$[CH_3COOCH_3]$/mol L^{-1}	0.40	0.20	0.10

a) Show that it follows pseudo first order reaction, as the concentration of water remains constant.

b) Calculate the average rate of reaction between the time interval 20 to 40 seconds.

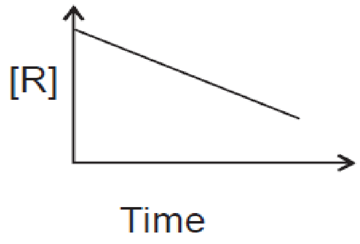
(ii) Why does the rate constant is nearly doubled for every 10° C rise in temperature?

(iii) Write the equation of temperature dependence rate of a chemical reaction.

2. (i) The rate constant of a first order reaction increases from 4×10^{-2} to 24×10^{-2} when the temperature changes from 300 K to 350 K. Calculate the energy of activation.

(log 2 = 0.301, log 3 = 0.4771, log 4 = 0.6021, log 6 = 0.7782)

(ii) Consider the reaction R → P. the change in concentration of R with time is shown in the following plot:

	a) Predict the order of reaction b) What does the slope of the above line indicate?

3. A) (i) For the reaction $2X \rightarrow X_2$, the rate of reaction becomes three times, when concentration of X is increased 27 times. What is the order of the reaction?

(ii) Write the rate equation for the reaction

$2A + B \rightarrow 2C$, if the order of the reaction is zero.

(iii) Oxygen is available in plenty in air, yet fuels do not burn by themselves at room Temperature. Explain.

(B) Rate constant for first order reaction has been found to be $2{\cdot}54 \times 10^{-3}\ s^{-1}$. Calculate its three- fourth life. [log 2 = 0·3010].

4. (a) (i) A reaction is 50% complete in 2 hours and 75% complete in 4 hours. What is the order of the reaction?

(ii) A first order reaction is 50% completed in 1.26×10^{14} s. How much time would it take for 100% completion?

(iii) The activation energy of a reaction is zero. Will the rate constant depend upon temperature? Explain.

(b) A reaction is first order in A and second order in B. Write the differential rate equation and calculate how the rate is affected when

(i) concentration of B is tripled, (ii) concentration of both A and B is doubled.

5. (i) If a zero-order reaction starts with the concentration of 10 mol/L, it's half-life is 2 minutes, what will be the half-life of the same reaction, if it is started with 20 mol/L?

(ii) Consider a certain reaction A → Products with $k = 2.0 \times 10^{-2}\ s^{-1}$. Calculate the concentration of a remaining after 100 s if the initial concentration of A is $1.0\ mol\ l^{-1}$

The *d*- and *f*-Block Elements

MCQs (1 Mark)

1. Which of the following metals does not liberate hydrogen gas with hydrochloric acid?
(a) Scandium
(b) Copper
(c) Nickel
(d) Zinc

2. The total number of unpaired electrons in Mn^{3+}, Cr^{3+}, and V^{3+} gaseous species is, and the most stable species is:
(a) 4, 3, and 2; V^{3+}
(b) 3, 3, and 2; Cr^{3+}
(c) 3, 3, and 3; Mn^{3+}
(d) 4, 3, and 2; Cr^{3+}

3. In alkaline solution, MnO_4^- changes to:
(a) MnO_4^{2-}
(b) MnO_2
(c) Mn_2O_3
(d) MnO

4. Which of the following pairs of ions has the same electronic configuration?
(a) Cu^{2+}, Cr^{2+}
(b) Fe^{3+}, Mn^{2+}
(c) Co^{3+}, Ni^{3+}
(d) Sc^{3+}, Cr^{3+}

5. At pH = X, CrO_4^{2-} (yellow) changes to $Cr_2O_7^{2-}$ (orange), and vice versa at pH = Y. What are the values of X and Y, respectively?
(a) 6 and 8
(b) 6 and 5
(c) 8 and 6
(d) 7 and 7

6. When steam is passed over red-hot iron, the substances formed are:
(a) $Fe_2O_3 + H_2$
(b) $Fe_3O_4 + H_2$
(c) $FeO + H_2$
(d) $Fe_2O_3 + H_2 + O_2$

7. The iron salt commonly used in blueprints or cyanotype process is:
(a) $FeCr_2O_4$
(b) $Fe_2(C_2O_4)_3$
(c) $K_3[Fe(CN)_6]$
(d) $FeSO_4$

8. When manganese dioxide is fused with KOH in air. It gives:
(a) $KMnO_4$
(b) K_2MnO_4
(c) Mn_3O_4
(d) $Mn(OH)_2$

9. Which of the following oxides is amphoteric in nature?
(a) SO_2
(b) ZnO
(c) MgO
(d) CO_2

10. The value of 'spin-only' magnetic moment for one of the following configurations is 2.84 BM. The correct one is:
(a) d^4 (in strong ligand field)
(b) d^4 (in weak ligand field)
(c) d^3 (in weak as well as strong fields)
(d) d^5 (in strong ligand field)

MCQ Answers:

1.	*(b)* Copper	**6.**	*(b)* $Fe_3O_4 + H_2$
2.	*(c)* 3, 3, and 3; Mn^{3+}	**7.**	*(c)* $K_3[Fe(CN)_6]$
3.	*(b)* MnO_2	**8.**	*(b)* K_2MnO_4
4.	*(b)* Fe^{3+}, Mn^{2+}	**9.**	*(b)* ZnO
5.	*(a)* 6 and 8	**10.**	*(a)* d^4 (in strong ligand field)

Assertion–Reason Questions (1 Mark)

(a) *Both Assertion (A) and Reason (R) are true, and Reason (R) is the correct explanation of Assertion (A).*
(b) *Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A).*
(c) *Assertion (A) is true, and the Reason (R) is false.*
(d) *Assertion (A) is false, but the Reason (R) is true.*

1. **Assertion (A) :** A solution of ferric chloride on standing give a brown precipitate.
Reason (R) : $FeCl_3$ possesses covalent bonds and chlorine-bridge structure.
Answer: (b)

2. **Assertion (A) :** Actinides are radioactive.
Reason (R) : They have unstable nuclei.
Answer: (a)

3. **Assertion (A) :** Lanthanides commonly show only the +3 oxidation state.
Reason (R) : 4*f* electrons are deeply buried and do not participate easily in bonding.
Answer: (b)

4. **Assertion (A) :** The degree of complex-formation in actinoids decreases in the order: $M^{4+} > MO^{2+} > M^{3+} > MO^{2+}$.
Reason (R) : Actinoids form complexes with π-bonding ligands such as alkyl phosphines and thioethers.
Answer: (b)

5. **Assertion (A) :** Silver is a non-transition element.
Reason (R) : Silver atom has completely filled *d* orbital, $4d^{10}$ in its ground state.
Answer: (d)

SAQs–I (2 Marks)

1. Draw the structure of dichromate ion and answer the following questions:
   (a) All Cr—O bond lengths in $Cr_2O_7^{2-}$ ion are not same. Why?
   Hint: Resonance in the two CrO_3 units sharing one oxygen atom.
   (b) Despite of the $3d^0$ electronic configuration of chromium, how come $K_2Cr_2O_7$ is coloured?
   Hint: Ligand to metal charge transfer spectra.

2. Explain the paramagnetic behaviour of manganate ion and diamagnetic behaviour of permanganate ion.
   Hint: Electronic configurations of MnO_4^{2-} and MnO_4^{-} ions.
3. How is potassium dichromate useful in the detection of SO_2 and Cl^- ions?
   Hint: It gives green and deep red colour when reacted respectively with SO_2 and Cl^- ions. (Reaction required)

4. What do you mean by 'disproportionation' of oxidation state? Give an example.
Hint: It has something to do with the oxidation and reduction of an element in a chemical reaction. Example,

$$3\,MnO_4^{2-} + 4\,H^+ \rightarrow ?$$

5. While both Cr^{2+} and Mn^{3+} have d^4 configuration, but the former is reducing in nature, while the latter acts as an oxidizing agent. Give reason.
Hint: The nature of these species can be explained on the basis of the most stable oxidation state of the metal.

6. A mixed oxide of iron and chromium, $FeO.Cr_2O_3$ is fused with sodium carbonate in the presence of air to form a yellow compound 'A'. On acidification, the compound 'A' forms an orange-coloured compound 'B' which is a strong oxidising agent. Identify:
(a) the compounds 'A' and 'B'.
Hint: $FeO.Cr_2O_3$ or chromite ore forms a compound of chromate with Na_2CO_3, which on acidification with HCl form a compound of dichromate.
(b) Write balanced chemical equations for each step.
Hint: The other two products of the first step are Fe_2O_3 and CO_2, while that of the second step are NaCl and H_2O.

7. Explain:
(a) $SnCl_2$ and $HgCl_2$ cannot exist together in an aqueous solution.
Hint: Consider the reducing nature of $SnCl_2$.
(b) HCl not used to acidify a permanganate solution in volumetric estimation of Fe^{2+} and oxalate ion.
Hint: Consider its oxidation.

8. Answer the following:
(a) Write the formula of an oxo-anion of manganese in which it shows the oxidation state equal to its group number.
Hint: The ion is a strong oxidizing agent.
(b) What happens when $(NH_4)_2Cr_2O_7$ is heated?
Hint: Orange sparks and a green, ash-like oxide of chromium is formed.

9. What are oxoanions? Why does the oxidizing power of the oxoanions in the 3*d* series follows the order: $VO^{2+} < Cr_2O_7^{2-} < MnO_4^-$?
Hint: Oxoanions are polyatomic ions of metals with oxygen. Consider the oxidation states and the electronic configuration of the metals present in the above ions.

10. In the first transition series:
(a) Which element shows maximum number of oxidation states?
Hint: The element with atomic number 25.
(b) Which element has the lowest enthalpy of atomization?
Hint: The element with atomic number 30.

SAQs–II (3 Marks)

1. Assign reasons to the following:
(a) There are no regular trends in E° values of M^{2+}/M systems in the 3*d* series.
Hint: Consider the irregularities in atomic sizes, stability of electronic configuration, screening effect, irregular ionization, sublimation and hydration enthalpies.

(b) Ce^{3+} can be easily oxidised to Ce^{4+}.
Hint: Consider the electronic configuration of these ions.

(c) Tantalum and palladium metals are used to electroplate coinage metals.
Hint: Consider tantalum and palladium's chemical inertness.

2. Calculate the equivalent mass of $KMnO_4$ when it acts as oxidizing agent in:

(a) Acidic medium

Hint: Equivalent mass of oxidizing agent = $\frac{\text{Molecular mass of the oxidizing agent}}{\text{No. of electrons gained by the oxidizing agent}}$

(b) Alkaline medium

Hint: Equivalent mass of oxidizing agent = $\frac{\text{Molecular mass of the oxidizing agent}}{\text{No. of electrons gained by the oxidizing agent}}$

(c) Why does the equivalent mass of $KMnO_4$ change with change in medium?

Hint: Consider the number of electron manganese gains in acidic and alkaline media.

3. Complete the following reactions:

(a) $Cr_2O_7^{2-} + 3H_2S + 8H^+ \rightarrow$

(b) $2MnO_4^- + 5SO_3^{2-} + 6H^+ \rightarrow$

(c) $2MnO_4^- + I^- + H_2O \rightarrow$

4. Account for the following:

(a) Both zinc and copper has completely filled 3*d* orbital. Copper is considered a transition element, but zinc is not.

Hint: Consider the +2 oxidation state of copper.

(b) The oxidation state of the metal in metal carbonyls is zero.

Hint: CO is a π-acceptor ligand.

(c) Despite being less electronegative that fluorine, oxygen stabilizes the higher oxidation states like +6 and +7 of the transition elements to a greater extent. Why?

Hint: Consider the valance of oxygen.

5. Answer the following questions:

(a) Justify the position of lanthanides and actinides in the same group of the modern periodic table.

Hint: Consider the comparable sizes and chemical properties of these metals.

(b) Which elements do the term ‘chemical twins’ commonly refers to?

Hint: These *d*-Block elements belong to different periods but have comparable sizes, and as a result, similar chemical properties.

(c) Uranium is the heaviest naturally occurring element. Name the only two synthetic elements that are lighter than and precede uranium.

Hint: You’ll find them in the second transition series and lanthanide elements.

6. Explain:

(a) Although zinc is on the right of copper in the periodic table, its atomic size is bigger. Explain.

Hint: Consider the screening effect in zinc.

(b) Why do the transition elements form strong metallic and covalent bonds?

Hint: Consider the less energy difference between $(n-1)$ *d* and *ns* orbitals.

(c) How does the trend of oxidation states of the *d*-Block elements differ from that of the *p*-Block elements?

Hint: In the *p*-Block elements, the oxidation state of an element increases by 2 due to the excitation of electrons from their *ns* and *np* orbitals to the *nd* orbital.

7. Classify the following complexes into paramagnetic and diamagnetic:

(a) $K_4[Fe(CN)_6]$

(b) $K_3[Fe(CN)_6]$

(c) $[Cr(H_2O)_6]^{3+}$

(d) $Ni(CO)_4$
(e) $[Co(CN)_6]^{3-}$
Hint: Consider the field strength of the ligand and determine the unpaired electrons.

8. Which of the following compounds are coloured and why?
(a) $CuSO_4.5H_2O$
(b) $Fe_4[Fe(CN)_6]_3$
(c) $KMnO_4$
(d) $[Zn(OH)_4]^{2-}$
(e) Cu_2O
(f) $[Ni(CN)_4]^{2-}$
Hint: The colour of the compounds can be explained on the basis of *d–d* transition and charge transfer spectra.

9. Name the element present in the following:
(a) Haemoglobin
(b) Cobalamin (Vitamin B_{12})
(c) Insulin
(d) Hemocyanin that transport oxygen in some invertebrates
(e) Cisplatin
(f) Lindlar catalyst
Hint: They all contain a *d*-Block metal.

10. Answer the following:
(a) What are coinage metals? In which group of the modern periodic table do they exist mostly?
Hint: Consider the minting of coins.

(b) Steel has different properties from iron. Why
Hint: Consider alloy and interstitial compound formed by the transition metals.

(c) Calculate the magnetic moment of iron in ferrocyanide and ferricyanide ions.
Hint: $\mu = \sqrt{n\,(n+2)}$ B.M.

CBQs (4 Marks)

1. Read the passage given below and answer the following questions:

The unique behaviour of Cu, having a positive E° accounts for its inability to liberate H_2 from acids. Only oxidising acids (nitric acid and hot and concentrated sulphuric acid) react with Cu, the acids being reduced.

The stability of the half-filled (d^5) subshell in Mn^{2+} and the completely filled (d^{10}) configuration in Zn^{2+} are related to their E° (M^{3+}/M^{2+}) values. The low value for Sc reflects the stability of Sc^{3+} which has a noble gas configuration. The comparatively high value for Mn shows that $Mn^{2+}(d^5)$ is particularly stable, whereas a comparatively low value for Fe shows the extra stability of Fe^{3+} (d^5). The comparatively low value for V is related to the stability of V^{2+} (half-filled t_{2g} level).

Answer the following questions:

(i) E° values for the couples Cr^{3+}/Cr^{2+} and Mn^{3+}/Mn^{2+} are −0.41 V and +1.51 V respectively. Which of the two shall act as reducing and which one will be an oxidizing agent?
Hint: Consider the most stable O.S. of these elements and their E° values.

(ii) Zinc is able to liberate hydrogen gas from hydrochloric acid, but copper is not. Explain in term of their reduction potentials.
Hint: The E° value of hydrogen is zero volts.

OR

Give reasons:

(a) Mn^{2+} compounds are more stable than Fe^{2+} towards oxidation to +3 state.
Hint: Consider the oxidation states.

(b) The E^o value for the Mn^{3+}/Mn^{2+} couple is much more positive than that for Cr^{3+}/Cr^{2+} or Fe^{3+}/Fe^{2+}.
Hint: Consider the oxidation states.

(iii) The reduction potential values of X, Y and Z are +2.46 V, −1.13 V and −3.13 V respectively. Arrange them in the order of their reducing property.
Hint: Z > Y > X

2. **Read the passage given below and answer the following questions:**

Diamagnetic substances are those which are weakly repelled by an applied magnetic field. Such substances have no unpaired electron. Paramagnetic substances are weakly attracted by the applied magnetic field. Transition metals and many of their compounds show paramagnetic behaviour where there are unpaired electron or electrons. The magnetic moment arises from the spin and orbital motions in ions or molecules. Magnetic moment of *n* unpaired electrons is given as, $\mu = \sqrt{n\,(n+2)}$ Bohr Magneton (B.M.). Magnetic moment increases as the number of unpaired electrons increases. Some metals like iron, cobalt, nickel, gadolinium and dysprosium are ferromagnetic. They are strongly attracted by the external magnetic field.

The following questions are multiple choice questions. Choose the most appropriate answer:

(i) In 3*d* transition series, the maximum magnetic moment is shown by chromium ($Z = 24$). Why?
Hint: Consider the number of unpaired electrons.

(ii) Out of Cr^{3+}, Fe^{2+} and Zn^{2+}, which ion has the least magnetic moment? State the reason.
Hint: Consider the unpaired electrons and the electronic configurations.

(iii) Arrange the following in the increasing value of their magnetic moments. Explain the order.

(I) $[Fe(CN)_6]^{4-}$ (II) $[Fe(CN)_6]^{3-}$
(III) $[Cr(NH_3)_6]^{3+}$ (IV) $[Ni(H_2O)_4]^{2+}$

Hint: I < II < IV < III

OR

Calculate the magnetic moment of $[Ni(CN)_4]^{2-}$ and $[Ni(H_2O)_4]^{2+}$ and explain their magnetic behaviours.
Hint: $[Ni(CN)_4]^{2-} = 0$ and $[Ni(H_2O)_4]^{2+} = 2.83$ B.M.

3. **Read the passage given below and answer the following questions:**

Most of the compounds of the transition metals are coloured in the solid or in solution states. The colour of the transition metal ions arises from the excitation of electrons from the lower energy *d* orbitals to the *d* orbitals of higher energy. The energy required for *d–d* transition is available in the visible range. Transition metal ions have the tendency to absorb certain radiations from the visible region and exhibit the complementary colour. The transition metal ions which have completely filled *d* orbitals are colourless as the excitation of electrons is not possible within *d* orbitals. The transition metal ions which have completely empty *d* orbitals are also colourless.

In certain oxysalts of transition elements like $KMnO_4$, $K_2Cr_2O_7$, there are no unpaired electrons at the central atom but they are deep in colour. The colour of these compounds is due to the charge transfer spectrum. For example, in MnO_4^-, an electron is transferred momentarily from O^{2-} to O^- and manganese from Mn^{7+} to Mn^{6+}.

Answer the following questions:

(i) What happens when $CuSO_4.5H_2O$ is heated in a dry test tube? Is the change physical or chemical?
Hint: Try performing the activity in the presence of your teacher.

(ii) Out of Cu^+, Cu^{2+}, Sc^{3+} and Zn^{2+}, which species is both paramagnetic and coloured? Why?
Hint: Consider unpaired electrons.

(iii) Explain *d–d* transition in detail. Which of the complex is likely to show *d–d* transition **$[Cr(H_2O)_6]^{3+}$** or $[Ti(H_2O)_6]^{4+}$?
Hint: Consider crystal-field splitting.

OR

Manganese has the oxidation state of +7 in MnO_4^- with no unpaired electrons in the *d* orbital. How come the ion is brightly coloured? Explain and give another example.
Hint: Consider charge transfer spectra.

4. The involvement of (n 1)d electrons in the behaviour of transition elements impart certain distinct characteristics to these elements. Thus, in addition to variable oxidation states, they exhibit paramagnetic behaviour, catalytic properties and tendency for the formation of coloured ions. The transition metals react with a number of non-metals like oxygen, nitrogen and halogens. KMnO4 and K2Cr2O7 are common examples. The two series of inner transition elements, lanthanoids and actinoids, constitute the f-block of the periodic table. In the lanthanoids, there is regular decrease in atomic size with increase in atomic number due to the imperfect shielding effect of 4f-orbital electrons which causes contraction.

Answer the following questions :

(a) Why do transition metals and their compounds act as good catalysts ? 1
(b) What is the cause of contraction in the atomic size of lanthanoids ? 1
(c) Define lanthanoid contraction. How does it affect the atomic radii of the third transition series and the second transition series ? 2

OR

(c) In aqueous media, which is a stronger reducing agent Cr2+ or Fe2+ and why

5. Transition metals have incomplete d-subshell either in neutral atom or in their ions. The presence of partly filled d-orbitals in their atoms makes transition elements different from that of the non-transition elements. With partly filled d-orbitals, these elements exhibit certain characteristic properties such as display of a variety of oxidation states, formation of coloured ions and entering into complex formation with a variety of ligands. The transition metals and their compounds also exhibit catalytic properties and paramagnetic behaviour. The transition metals are very hard and have low volatility. An examination of the E0 values E^0M^{2+} /M shows the varying trends

E^0M^{2+} /M	
V	-1.18
Cr	-0.91
Mn	-1.18
Fe	-0.44
Co	-0.28
Ni	-0.25
Cu	+ 0.34
Zn	0.76

Answer the following questions :

(a) On what basis can we say that Cu is a transition element but Zn is not ? (Atomic number : Cu = 29, Zn = 30)

(b) Why do transition elements show variety of oxidation states ? 1

(c) (i) Why do E0 values show irregular trend from Vanadium to Zinc ?

(ii) How is the variability in oxidation states of transition metals different from that of the non-transition elements ?

OR

(c) (i) Of the d4 species, Cr2+ is strongly reducing while Mn3+ is strongly oxidizing.

Why ? (Atomic number : Cr = 24, Mn = 25)

LAQs (5 Marks)

1. Identify A to E. Pyrolusite on heating with KOH in the presence of air gives a dark green compound ‘A’. The solution of ‘A’ on treatment with H_2SO_4 gives a purple-coloured compound ‘B’.
Hint: Industrial preparation of $KMnO_4$.
Compound ‘B’ gives the following reactions:
(a) KI on reaction with alkaline solution of ‘B’ changes into a compound ‘C’.
Hint: Alkaline MnO_4^- oxidizes I^- to IO_3^-.
(b) The colour of the compound ‘B’ disappears on treatment with the acidic solution of $FeSO_4$.
Hint: Acidic MnO_4^- oxidizes Fe^{2+} to Fe^{3+}.
(c) With conc. H_2SO_4 compound ‘B’ gives ‘D’ which can compose to yield ‘E’ and oxygen.
Hint: $KMnO_4$ reacts with conc. H_2SO_4 and forms Mn_2O_7.

2. When a white crystalline compound ‘X’ is heated with $K_2Cr_2O_7$ and concentrated H_2SO_4 a reddish-brown gas ‘A’ is evolved. On passing ‘A’ into caustic soda solution, a yellow-coloured solution ‘B’ is obtained. Neutralizing the solution ‘B’ with acetic acid on subsequent addition of lead acetate, a yellow precipitate ‘C’ is formed. When ‘X’ is heated with NaOH solution, a colourless gas is evolved and on passing this gas into K_2HgI_4, solution, a reddish-brown precipitate ‘D’ is formed. Identify ‘A’, ‘B’, ‘C’, ‘D’ and ‘X’. Write the equations of the reactions involved.
Hint: ‘X’ = NH_4Cl
‘A’ = CrO_2Cl_2
‘B’ = Na_2CrO_4
‘C’ = $PbCrO_4$
‘D’ = $NH_2HgOHgI$

3. An aqueous solution of a compound ‘A’ is acidic towards litmus, and it sublimes at about 300° C.‘A’ on treatment with an excess of NH_4SCN gives a red coloured compound ‘B’, and on treatment with a solution of $K_4[Fe(CN)_6]$ gives a blue coloured compound ‘C’. ‘A’ on heating with excess of $K_2Cr_2O_7$ in the presence of conc. H_2SO_4 evolves deep red vapours of ‘D’. On passing the vapours of ‘D’ into a solution of NaOH and then adding the solutions of acetic acid and lead acetate, a yellow precipitate of compound ‘E’ is obtained. Identify compounds ‘A’ to ‘E’ and give the chemical reactions involved.
Hint: ‘A’ = $FeCl_3$
‘B’ = $Fe(SCN)_3$
‘C’ = $K_4[Fe(CN)_6]_3$
‘D’ = CrO_2Cl_2
‘E’ = $PbCrO_4$

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COORDINATION COMPOUND

Section A: Multiple Choice Questions (1 mark × 10 = 10 marks)

1	A ligand forms two different complexes: $[Co(NO_2)(NH_3)_5]Cl_2$ (yellow) and $[Co(ONO)(NH_3)_5]Cl_2$ (red). What type of isomerism does this illustrate? a) Coordination isomerism b) Ionisation isomerism c) Linkage isomerism d) Geometrical isomerism
2	A compound $[CoCl_2(en)_2]Cl$ shows optical activity but another form does not. What can be inferred? a) Optical isomerism is due to chloride ions b) Optical activity arises from symmetrical ligands c) The inactive isomer is trans-form d) The compound contains inner orbital complex
3	A conductivity test on $[Cr(H_2O)_6]Cl_3$ shows a high value. What conclusion can you draw about ionisable components? a) Only one ion forms b) All Cl^- are inside coordination sphere c) Three Cl^- are ionisable d) The complex is neutral
4	One isomer of $[Pt(NH_3)_2Cl_2]$ binds to DNA and is used in chemotherapy. Based on ligand positions, which isomer is more reactive? a) Cis-isomer due to adjacent Cl^- ligands b) Trans-isomer because it is less polar c) Trans-isomer due to faster hydrolysis d) Both have equal activity
5	$[Ni(H_2O)_6]^{2+}$ reacts with CN^- to form $[Ni(CN)_4]^{2-}$, which is diamagnetic. What change in ligand field explains this? a) Weak field ligand effect b) Strong field ligand caused pairing c) Oxidation of nickel d) Loss of d-electrons due to water
6	Two cobalt complexes yield different AgCl precipitates when treated with $AgNO_3$. What could be a possible explanation? a) Oxidation state is different b) Geometry differs c) Ionisation isomerism d) Coordination number changes
7	$[Fe(H_2O)_6]^{2+}$ appears pale green while $[Fe(CN)_6]^{4-}$ is almost colourless. Which factor best explains this observation? a) d-d transitions are not allowed b) Ligand field strength differs c) Both are low spin d) Water absorbs visible light
8	A student observes $[Co(en)_3]^{3+}$ rotates plane polarised light but $[Co(NH_3)_6]^{3+}$ does not. What structural property is responsible? a) Geometrical isomerism b) Optical isomerism c) Ligand is ionisable d) Coordination number changes
9	Chelating ligands form more stable complexes due to: a) Greater charge on metal b) Larger size of central atom c) Multiple coordination bonds d) Presence of unpaired electrons
10	$[NiCl_4]^{2-}$ and $[Ni(CN)_4]^{2-}$ show different magnetic behaviour. What does this difference suggest about ligand effects? a) CN^- causes stronger splitting, leading to pairing b) Cl^- and CN^- both cause low pairing c) CN^- is weak field ligand d) Ni is in different oxidation states

Assertion and Reason Questions (1 mark × 5 = 5 marks)

Choose the correct option:

a) Both A and R are true, and R is the correct explanation of A.

	b) Both A and R are true, but R is not the correct explanation of A. c) A is true but R is false. d) A is false but R is true.
11.	**Assertion:** $[Fe(CN)_6]^{3-}$ is less reactive toward substitution than $[Fe(H_2O)_6]^{3+}$. **Reason:** CN^- is a strong field ligand and forms low-spin inert complexes.
12	**Assertion:** $[Co(en)_3]^{3+}$ rotates plane polarised light. **Reason:** The complex has a chiral geometry due to arrangement of bidentate ligands.
13	**Assertion:** $[Cr(H_2O)_6]Cl_3$ gives three ions in solution. **Reason:** All three chloride ions are outside the coordination sphere.
14	**Assertion:** Square planar complexes can show geometrical isomerism. **Reason:** Spatial position of identical ligands allows cis–trans forms.
15	**Assertion:** $[Pt(NH_3)_2Cl_2]$ shows different melting points for its isomers. **Reason:** Physical properties vary due to different spatial arrangements of ligands.

Section B: Short Answer Type Questions (2 marks × 10 = 20 marks)

16. Two chromium(III) complexes – $[Cr(H_2O)_6]Cl_3$ and $[CrCl(H_2O)_5]Cl_2$ – are tested for conductivity. The first gives a higher reading. Use the formula and ionisation concept to explain the result.
17. A pale green Ni^{2+} solution turns colourless and diamagnetic after addition of excess KCN. Identify the product formed and explain the observed changes using crystal field theory.
18. Why does only the cis-isomer show anti-cancer activity and not the trans-isomer.
19. A metal ion is surrounded by four monodentate and one bidentate ligand. Determine the coordination number and explain your reasoning.
20. A student compares the molar conductivity of three chromium complexes with increasing number of coordinated chloride ions. Predict and explain the trend based on ionisation and ligand position.
21. Compare the magnetic moment of $[Fe(H_2O)_6]^{2+}$ and $[Fe(CN)_6]^{4-}$ using electron configurations of CFT.
22. When tested under a spectrophotometer, $[Fe(H_2O)_6]^{2+}$ shows strong absorption in visible light, whereas $[Zn(H_2O)_6]^{2+}$ does not. Explain the difference based on electronic configurations.
23. A new calcium supplement uses a chelating ligand instead of simple salts. Predict how chelation affects metal ion availability and stability in biological systems.
24. A complex turns brown and releases a gas on heating. Predict a possible structural change in the complex, and explain it using ligand field or thermal decomposition reasoning.
25. A transition metal complex changes from paramagnetic to diamagnetic upon addition of CN^-. Identify the type of ligand field change and justify using crystal field theory.

Section C: Short Answer Type Questions (3 marks × 10 = 30 marks)

26. An organometallic compound containing a transition metal and CO ligands shows a lower C–O stretching frequency in its IR spectrum compared to free CO. The same compound also shows no magnetic moment.
    Use this information to deduce the type of bonding interactions occurring between the metal and CO, and explain the electronic condition of the metal that leads to this IR observation and magnetic behavior.

27. A laboratory technician wants to distinguish between cis and trans forms of $[Pt(NH_3)_2Cl_2]$. Design an experiment based on chemical reactivity or melting point to differentiate them and explain your choice.
28. A nickel(II) complex with CN^- ligand is found to be square planar and diamagnetic, unlike its Cl^- counterpart which is tetrahedral and paramagnetic. Explain this observation using orbital diagrams and ligand field theory.
29. A sample of $[Co(en)_2Cl_2]^+$ exists in two forms: one optically active, the other not. Using a 3D structural diagram, explain how chirality arises and identify which form is optically active.
30. A student replaces water ligands in $[Co(H_2O)_6]^{2+}$ stepwise with NH_3 and observes increasing stability. Explain this trend using formation constants and chelate effect.
31. A person suffering from heavy metal poisoning is given a chelating agent like EDTA. Explain how this agent works with an example of a stable chelate complex.

32. Predict whether $AgNO_3$ will give a precipitate with $[CrCl_2(H_2O)_4]^+$. Use ionisation concepts and coordination sphere knowledge to justify your answer.
33. Explain why $[Cu(H_2O)_6]^{2+}$ appears blue while $[Zn(H_2O)_6]^{2+}$ is colourless. Use orbital diagrams and d-d transitions in your answer.
34. Two ligands – NH_3 and en – are used to form nickel(II) complexes. Compare the stability of $[Ni(NH_3)_6]^{2+}$ and $[Ni(en)_3]^{2+}$ using the chelate effect and entropy considerations.
35. A student is given two cobalt(III) complexes: $[Co(NH_3)_5SO_4]NO_3$ and $[Co(NH_3)_5NO_3]SO_4$. Design a test using $BaCl_2$ and $AgNO_3$ to identify the ionisation isomer and predict the observations.

Section D: Case-Based Questions (4 marks × 3 = 12 marks)

36. **Case 1:**

Two solid salts, labelled Compound A and Compound B, have the same empirical formula:
$FeSO_4 \cdot (NH_4)_2SO_4 \cdot 6H_2O$
When dissolved in water:

- Compound A gives a positive test for all its constituent ions (Fe^{2+}, NH_4^+, SO_4^{2-}).
- Compound B, when treated with potassium ferrocyanide, gives a deep blue precipitate. However, it does not give a positive test for Fe^{2+} ions using sodium hydroxide immediately after dissolution.

A student notes that both compounds contain Fe^{2+} but behave differently in ionic tests.
Based on this information, answer the following:
(a) Which compound is more likely to dissociate completely in aqueous solution?
(b) Explain which compound retains a complex ion in solution and predict its behavior with $AgNO_3$.Compare the number of ions produced by each compound in aqueous solution.
(c) Suggest a method to distinguish between the two compounds using a simple laboratory test.
OR
(c) Predict the type of bonding present in Compound B that leads to its unique behavior.

37. **Case 2:**

A chemist is developing a new catalyst based on platinum complexes. Two forms of $[Pt(NH_3)_2Cl_2]$ were synthesized. One isomer is highly effective in initiating a reaction at low temperatures, while the other shows no catalytic activity. Structural analysis reveals spatial arrangement of ligands is the key.
a) Which isomer is more reactive in such catalytic systems? Why?
b) Name and explain the type of isomerism involved.
c) How does ligand position influence reactivity?
OR
c) Give a real-world example where such a platinum complex is used.

38. **Case 3:**

A chemist observed two different complexes of Mn^{2+} with the same oxidation state and similar ligands:
Compound A: $[Mn(H_2O)_6]^{2+}$
Compound B: $[MnCl_4]^{2-}$
Both compounds are colored and paramagnetic, but differ in magnetic moment and color intensity. The magnetic moment of Compound A is higher than Compound B, and UV-Visible spectroscopy shows a larger Δ value for Compound A.
Based on this data:
(a) Assign probable geometries to both compounds.
(b) Compare the CFSE values for both and explain the observed color difference.
OR
(b) if CFSE of octahedral compond is 18000 cm^{-1}. Find the CFSE of tetrahedral compound.
(c) Identify which compound is more stable on the basis of CFSE, and justify your choice using orbital splitting concepts.

Section D: Long Answer Type Questions (5 marks × 3 = 15 marks)

39. A chemist reacts cobalt(III) chloride with ethylenediamine to form a violet compound. Write the formula of the complex formed and draw its possible optical isomers. Explain why it shows optical activity.
40. A solution of $[Fe(H_2O)_6]^{2+}$ is oxidised slowly when exposed to air. Explain the redox stability of Fe^{2+}/Fe^{3+} in aqueous medium and predict the colour changes observed during oxidation.
41. A student incorrectly named a compound as *tetraamminediaquacopper(II) sulfate*. The teacher pointed out that the name does not match the observed formula: $[Cu(NH_3)_4(H_2O)_2]SO_4$.Identify and correct the mistakes in the name using IUPAC rules. Also, provide one example each of a coordination compound where:
    a)The counter ion is a cation
    b)The ligand is bidentate
    c)The overall charge on the complex ion is negative

Answers

- **Section A: MCQs (1 mark × 10)**

1. **c)** Linkage isomerism – NO_2^- and ONO^- differ in donor atoms
2. **c)** Trans-isomer is optically inactive; only cis-form is chiral
3. **c)** Three Cl^- are ionisable → high conductivity
4. **a)** Cis-isomer → adjacent Cl^- bind DNA
5. **b)** CN^- = strong field → electron pairing → diamagnetic
6. **c)** Ionisation isomerism → different free Cl^-
7. **b)** Colour difference due to ligand field strength
8. **b)** $[Co(en)_3]^{3+}$ is optically active due to chirality
9. **c)** Only one Cl^- outside → gives 1 mole AgCl
10. **a)** CN^- = strong field → low-spin complex → paired e^-

    Assertion and Reason Questions – Answer Hints:

11. a) Both statements are true; CN^- creates stable low-spin complexes.
12. a) Chiral geometry leads to optical activity in $[Co(en)_3]^{3+}$.
13. a) All Cl^- are outside the coordination sphere → 3 ions.
14. a) Geometrical isomerism arises in square planar due to cis–trans forms.
15. a) Different spatial arrangements lead to different melting points.

Section B: Short Answers (2 marks × 10)

16. $[Cr(H_2O)_6]Cl_3$ gives 4 ions; $[CrCl(H_2O)_5]Cl_2$ gives 3 → higher conductivity for former
17. $[Ni(CN)_4]^{2-}$ formed; CN^- → strong field → square planar → diamagnetic & colourless
18. Cis-form allows both Cl^- to bind DNA; trans does not
19. 4 monodentate + 1 bidentate = Coordination number = 6
20. More Cl^- outside → more ionisation → higher conductivity
21. Fe^{2+}: d^6 → H_2O weak field = high-spin (unpaired), CN^- = low-spin (paired)
22. Fe^{2+}: d–d transitions → coloured; Zn^{2+}: d^{10} → no d–d transitions
23. Chelation increases bioavailability, stability (e.g., Ca–EDTA)
24. Colour change + gas → ligand loss or thermal decomposition
25. CN^- causes pairing in d orbitals → paramagnetic to diamagnetic

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Section C: Short Answers (3 marks × 10)

26. Metal–CO bonding = σ-donation + π-backbonding → synergic; pairing → diamagnetic
27. Use melting point or DNA binding test to distinguish cis & trans
28. CN^- → square planar, diamagnetic; Cl^- → tetrahedral, paramagnetic
29. Cis-isomer → chiral due to bidentate ligands → optically active
30. NH_3 stronger than H_2O → higher stability; chelate effect enhances stability
31. EDTA binds metal ion via multiple sites → stable chelate → detox
32. One Cl^- is free (outside), gives AgCl with $AgNO_3$
33. Cu^{2+} has d–d transitions → blue; Zn^{2+} is d^{10} → no colour
34. en is bidentate → chelate effect → more stable than NH_3 complex
35. $BaCl_2$ detects SO_4^{2-}; $AgNO_3$ detects NO_3^- → identify ionisation isomer

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Section D: Case-Based (4 marks × 3)

36.Case 1:

a) A dissociates completely → double salt
b) B retains complex → fewer ionisable ions
c) A: more ions; B: fewer → lower conductivity
d) Use $AgNO_3$ test or conductance meter
(OR) d) B → coordinate bonding holds Fe^{2+} in complex

37.Case 2:

a) Cis-isomer more reactive → adjacent Cl^-
b) Geometrical isomerism
c) Ligand position affects accessibility/reactivity
(OR) d) Cisplatin → used in cancer treatment

38.Case 3:

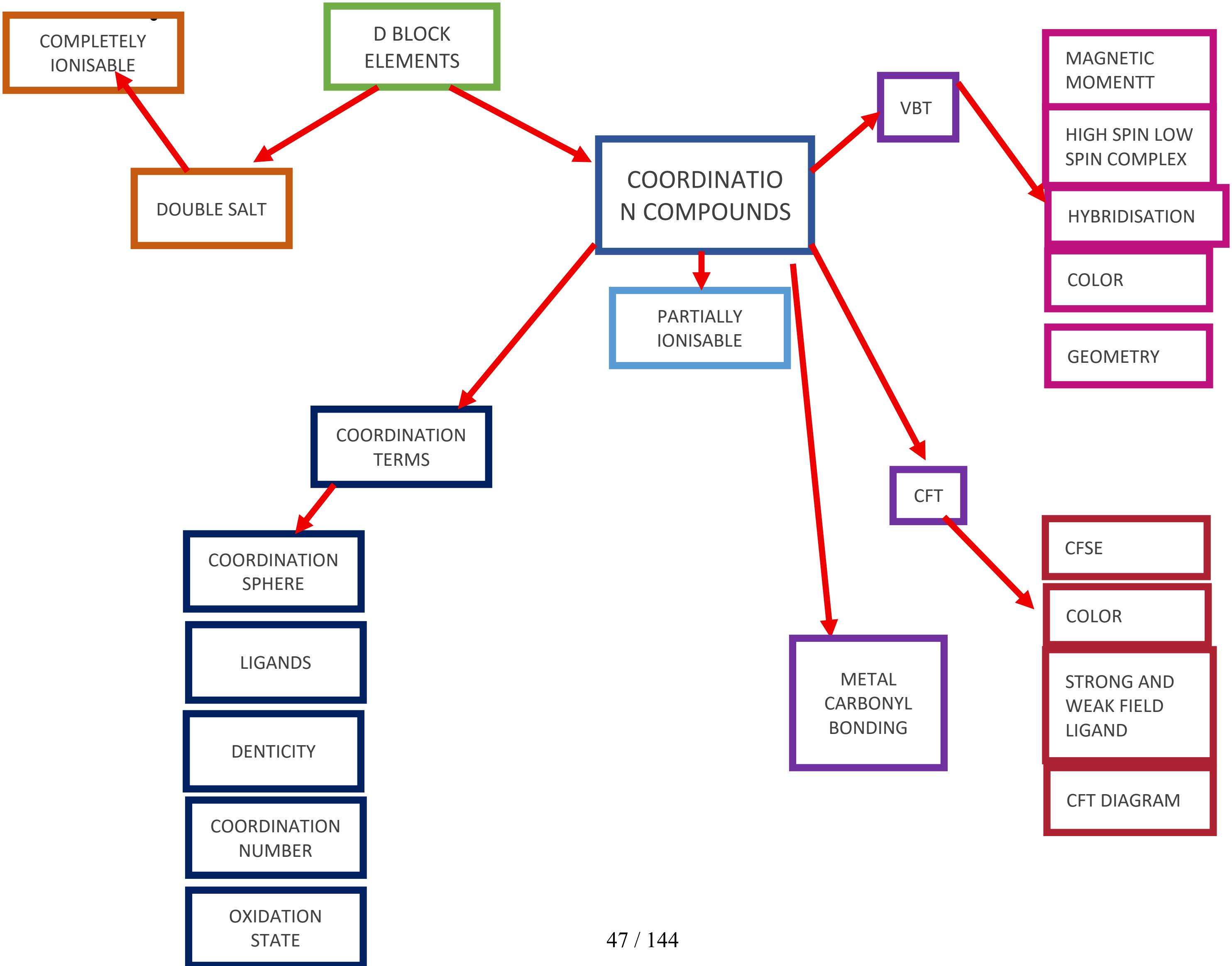
a) A = Octahedral; B = Tetrahedral
b) The octahedral compound → more CFSE→color absorb of higher frequency

OR

b) $\Delta_t = (4/9) \times 18{,}000 = 8000$
c) Compound A more stable due to higher CFSE.

Section E: Long Answers (5 marks × 3)

39.$[Co(en)_3]^{3+}$ → shows optical isomerism → chiral geometry due to 3 bidentate ligands
40.Fe^{2+} oxidises to Fe^{3+} in air → colour changes from pale green to yellow-brown
41.Name error: "tetraamminediaquacopper(II) sulfate" is correct
  a) e.g., $[Cu(NH_3)_4]^{2+}SO_4^{2-}$ → counter ion is cation
  b) e.g., $[Co(en)_3]^{3+}$ → bidentate ligand
  c) e.g., $[Fe(CN)_6]^{4-}$ → negative complex



HALOALKANES AND HALOARENES
MULTIPLE CHOICE QUESTIONS (1 MARK EACH)

1. Which of the following alkyl halides will undergo S_N1 reaction most readily ?
(a) $(CH_3)_3C\text{-}F$ (b) $(CH_3)_3\ C\text{-}CI$
(c) $(CH_3)_3C\text{-}Br$ (d) $(CH_3)_3C\text{-}I$

2 Chlorination of toluene in the presence of light and heat following by treatment with aq. NaOH gives.
(a) o-cresol (b) p-cresol
(c) mixture of o-cresol and p-cresol (d) benzoic acid

3 What should be the correct IUPAC name for diethyl bromomethane?
(a) 1-Bromo-1,1-diethylmethane (b) 3-Bromopentane
(c) 1-Bromo-1-ethylpropane (d) 1-Bromopentane

4 Gem-dibromide- is :
(a) $CH_3CH\ (Br)\ CH_2\ (Br)$ (b) $CH_3CBr_2CH_3$
(c) $CH_2\ (Br)CH_2\ CH_2$ (d) $CH_2\ BrCH_2Br$

5 S_N1 Reaction of alkyl halides lead to:
(a) retention of configuration (b) racemisation
(c) inversion of configuration (d) none of these.

6. Which reagents are required for one step conversion of chlorobenzene to toluene ?
(a) $CH_3Cl/AICl_3$ (b) CH_3Cl,Na, Dry ether
(c) CH_3Cl/Fe dark (d) $NaNO_2/HCI/0\text{-}5^0C$

7. Identify the structure of 1-Bromo-4 chlorobut-2-ene among the following.
(a) $CH_3BrC{=}CHCH_2Cl$ (b) $CICH_2CH{=}CHCH_2\ Br$
(c) $BrCH_2\ CH{=}CHCH_2CI$ (d) $BrCH_2CH{=}CClCH_3$

8. Which of the following will be the major product formed in reaction below?
$CH_3\text{-}CH_2\text{-}CH{=}CH_2\ +\ HBr \rightarrow\ ?$
(a) $CH_3\text{-}CH_2\text{-}CH_2\text{-}CH_2Br$ (b) $CH_3\text{-}CH_2\text{-}CHBr\text{-}CH_3$
(c) $CH_3\text{-}CHBr\text{-}CH{=}CH_2$ (d) $CH_3\text{-}CH{=}CH\text{-}CH_2Br$

9. Which of the following molecules exhibits optical isomerism?
(a) 3-iodopentane (b) 2-iodo-2-methylpropane
(c) 1,3-diiodopropane (d) 2-iodobutane

10 The decreasing order of boiling points of alkyl halides is :
(a) RF>RCl>RBr>RI (b) RBr>RCl>RI>RF
(c) RI>RBr>RCl>RF (d) RCl>RF>RI>RBr

11 Given below are four haloalkane compounds.

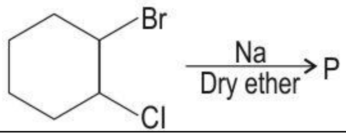
tert-bromobutane, tert-iodobutane, iodobutane, bromobutane
Which of them would be the most easily undergo S_N1 and S_N2 reactions?

OPTION		
P	tert-iodobutane	Iodobutane
Q	tert-bromobutane	bromobutane
R	iodobuane	tert-iodobutane
S	bromobutane	tert-bromobutane

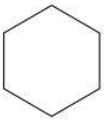
a) P. b). Q. c) R. d) S

12 Which of the following compounds will be hydrolysed most rapidly under similar reaction conditions?

A. 1-chloropropane B. 1-chlorobutane
C. 2-chloro-2-methylpropane D. 2-chlorobutane

13


Which of the following products will be formed as P?

(1)


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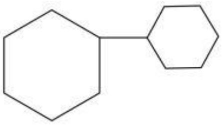
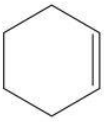


(3)


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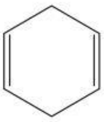


A. 1. B. 2 C. 3 D. 4

Answers

1	2	3	4	5	6	7	8	9	10
d	d	b	b	b	b	c	b	d	C
11	**12**	**13**							
a	D	C							

Assertion-Reason Type Questions (1 mark each)

Directions: Two statements are given one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c), (d) are given as follows.

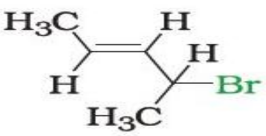
(a) Both (A) and (R) are true and (R) is the correct explanation of (A).
(b) Both (A) and (R) are true but (R) is not a correct explanation of (A).
(c) (A) is true but (R) in false
(d) (A) is false, but (R) is true.

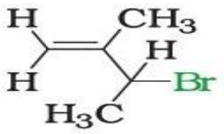
1. **Assertion (A):** Nucleophilic substitution of iodoethane is easier than chloroethane.
   Reason (R): Bond enthalpy of C-I bond is less than that of C-Cl bond.
2. **Assertion (A):** Nitration of chlorobenzene leads to the formation of m-nitrochlorobenzene.
   Reason (R): -NO_2 group is a m-directing group.
3. **Assertion (A):** It is difficult to replace chlorine by -OH in chlorobenzene in comparison to that in chloroethane.
   Reason (R) Chlorine-carbon (C-Cl) bond in chlorobenzene has a partial double bond character due to resonance
4. **Assertion (A):** In monohaloarenes, further electrophilic substitution occurs at ortho and para positions.
   Reason (R): Halogen atom is a ring deactivator.
5. **Assertion (A):**Aryl iodides can be prepared by reaction of arenes with iodine in the presence of an oxidising agent.
   Reason (R): Oxidising agent oxidises I_2 into HI.

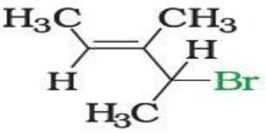
1	2	3	4	5
a	d	a	b	c

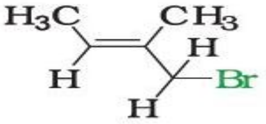
SHORT ANSWER QUESTIONS (2 MARKS)

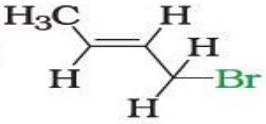
1. **Write IUPAC names of the following**:

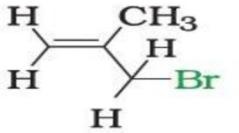
(i)


(ii)


(iii)


(iv)


(v)


(vi)


2. **Write the structures of the following:**
(i) 2-chloro-3-methylbutane (ii) 3-chloro-4- methylhexane (iii) 1-iodo-2,2-dimethylbutane
(iv) 1-bromo-3,3-dimethyl-1-phenylbutane

3. **How will you Convert** : (a) Benzene into 4- bromonitrobenzene
(b) Benzyl chloride to 2-phenyl acetic acid

4. **Arrange in order of boiling points**.
(a) Bromobenzene, bromoform, chloromethane, di bromomethane
(b) 1-chloropropane, isopropylchloride, 1-chlorobutane

5. **How will you distinguish between the following pairs of compounds?**
(i) Chloroform and carbon tetra chloride.
(ii) Benzyl alcohol and chlorobenzene.

6. A hydrocarbon C_5H_{10} does not react with chlorine in dark but gives a single monochloro compound C_5H_9Cl in bright sunlight. Identify the hydrocarbon.

7. Identify the product $C_6H_5CH_2CH(Cl)C_6H_5 + KOH(alc.) \xrightarrow{Heat}$ [A]

8. Why do alkenes prefer to undergo electrophilic addition reaction while arenes prefer electrophilic substitution reactions? Explain.

9. Write the chlorination reaction of butane?

10. (a) Why is Butan-1-ol optically inactive but Butan-2-ol is optically active?
(b) Why is 2-bromobutane optically active but 1-bromobutane is optically inactive.

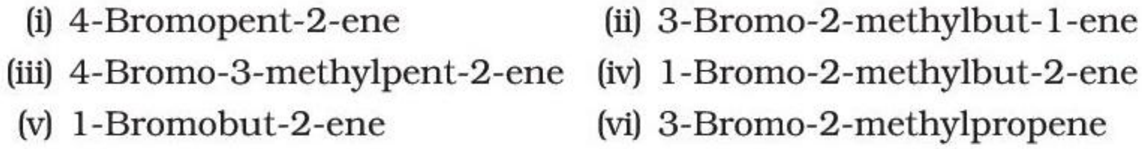
11. a) Give a reason why vinyl halides generally do not undergo nucleophilic substitution reactions.

b) To prepare a Grignard reagent, Udita mixes magnesium metal in dry ether with the compound shown below.

$CH_3 - CHOH - CH_2 - CH_2Br$
Will she obtain the Grignard reagent? Justify your answer.

Answers

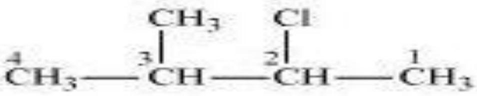
Hints 1. IUPAC NAMES



(i) 4-Bromopent-2-ene
(ii) 3-Bromo-2-methylbut-1-ene
(iii) 4-Bromo-3-methylpent-2-ene
(iv) 1-Bromo-2-methylbut-2-ene
(v) 1-Bromobut-2-ene
(vi) 3-Bromo-2-methylpropene

Hints 2.

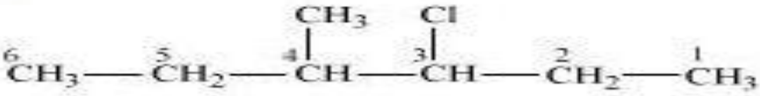
(i)



2–Chloro–3–methylbutane

(Secondary alkyl halide)

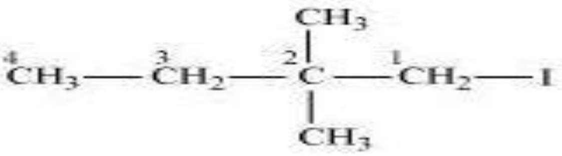
(ii)



3–Chloro–4–methyhexane

(Secondary alkyl halide)

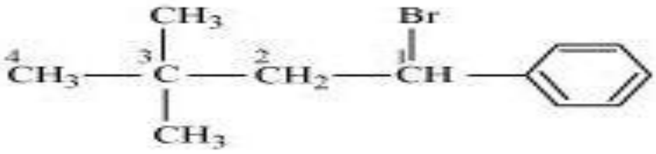
(iii)



1–Iodo–2, 2 –dimethylbutane

(Primary alkyl halide)

(iv)



1–Bromo–3, 3–dimethyl–1–phenylbutane

Hints 3 (a) CONVERSIONS

Ans (b) reaction with KCN than hydrolysis

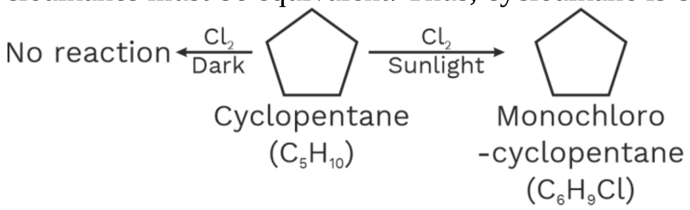
Hints 4 (a) chloromethane<Bromobenzene< di bromomethane bromoform

(b) isopropylchloride < 1-chloropropane,< 1-chlorobutane

a) On heating chloroform and carbon tetrachloride with aniline and ethanolic potassium hydroxide separately chloroform forms pungent smelling isocyanide but carbon tetrachloride does not form this compound.

(b) On adding sodium hydroxide and silver nitrate to both the compounds benzyl chloride forms white precipitate but chloro benzene does not form white precipitate.

Hints 6: Hydrocarbon with molecular formula C_5H_{10} can either be a cycloalkane or an alkene. Since, compound does not react with Cl_2 in dark, therefore it cannot be an alkene but must be a cycloalkane. Since, cycloalkane reacts with Cl_2 in presence of bright sunlight to give a single monochloro compound, C_5H_9Cl, therefore, all ten hydrogen atoms of cycloalkanes must be equivalent. Thus, cycloalkane is cyclopentane.



Hints7: $C_6H_5CH=CHC_6H_5$, as KOH(alc) generates a stronger base RO$^-$ and elimination reaction proceeds.

Hints8: (i) Benzene posses an unhybridised p-orbital containing one electron . The lateral overlap of their p-orbitals produces 3π- bonds.

(ii) Due to delocalisation strong π- bond is formed which makes the molecule stable therefore benzene undergoes electrophilic substitution reaction whereas alkenes undergoes addition reaction .

Ans9 chlorination reaction of butane

$$CH_3CH_2CH_2CH_3 \xrightarrow[\text{or heat}]{Cl_2/\text{UV light}} CH_3CH_2CH_2CH_2Cl + CH_3CH_2CHClCH_3$$

Ans 10 (a) A chiral carbon atom is one that is bonded to four different groups.

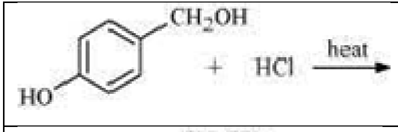
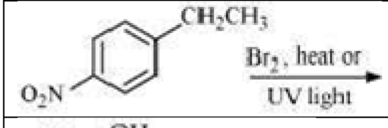
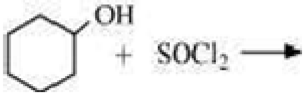
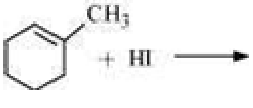
Ans . a) Vinyl halides generally do not undergo nuclepohilic substitution reactions. This is because the partial double bond character of the C-Cl bond makes it difficult to break.

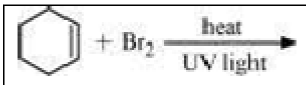
b) i)She will not obtain the Grignard reagent.

ii) As the Grignard reagent is formed it will immediately be protonated by the alcoholic group in the compound X.

SHORT ANSWER QUESTIONS (3 MARKS)

1. Anita was given two haloalkanes — *1-bromobutane* and *2-bromobutane*. She performed nucleophilic substitution using aqueous KOH. The reaction was faster with 1-bromobutane.
   (a) Identify the type of mechanism involved for both.
   (b) Name the product of both reactions.
   (c) What is the stereochemical outcome in each case?
2. Chlorofluorocarbons (CFCs) such as Freon-12 are widely used but pose environmental hazards.
   (a) Explain how CFCs affect the ozone layer.
   (b) Suggest an eco-friendly alternative and explain its advantage.
   (c) Classify Freon-12 as a haloalkane or haloarene and justify.
3. During a practical class, a student tried to prepare ethyl iodide from ethyl bromide using NaI in acetone.
   (a) Identify the reaction and name it.
   (b) Why is acetone used as a solvent?
   (c) Write the balanced chemical equation.
4. How will you convert toluene into O-halo toluene?
5. Complete the following equations:


$CH_3CH_2Br + NaI \longrightarrow$

6. What happens when **chlorobenzene** is heated with NaOH at 623 K and 300 atm?
7. Explain the role of peroxide in the reaction of HBr with alkene.
8. Convert. (a) prop-1-ene to 1- fluoropropane
   (b) chloro benzene to 2- chlorotoluene. (c) ethanol to propanenitrile

9. (a) Although chlorine is an electron withdrawing group, yet it is ortho-, para-directing in electrophilic substitution reactions. Explain why it is so?

   (b) The presence of nitro group ($-NO_2$) at o/p positions increases the reactivity of nucleophilic substitution reactions of haloarenes. Explain.
10. Write chemical equations when,
    (a) chlorobenzene is treated with CH_3COCl in presence of anhydrous $AlCl_3$.
    (b) chlorobenzene is treated with CH_3Cl in the presence of anhydrous $AlCl_3$.
    (c) bromobenrene is treated with CH_3Cl in the presence of anhydrous $AlCl_3$.
11. Study the reaction below and answer the questions that follow:

$$CH_3Cl + NaI \rightarrow CH_3I + NaCl$$

i) How can we increase the rate of the forward reaction?

ii) If methyl fluoride is to be prepared by the above process, state the reactants?

iii) Arrange methyl iodide, methyl fluoride and methyl chloride in the decreasing order of their dipole moment.

12. An organic compound with the formula C_6H_5Br reacts with CuCN to form compound 'P' and CuBr in presence of pyridine at 475 K. Compound P on reaction with dil. HCl forms compound 'Q' which reacts with methyl alcohol produces a sweet smelling compound 'R'.Write the chemical reaction showing the above conversions
13. A compound (A) with molecular formula C_4H_9I which is a primary alkyl halide, reacts with alcoholic KOH to give compound (B). Compound (B) reacts with HI to give (C) which is an isomer of (A). When (A) reacts with Na metal in the presence of dry ether, it gives a compound (D), C_8H_{18}, which is different from the compound formed when n-butyl iodide reacts with sodium. Write the structures of (A), (B), (C) and (D). Write the chemical equation when compound (A) is reacted with alcoholic KOH

Answers

1. (a) 1-bromobutane: SN^2 mechanism2-bromobutane: SN^1 mechanism (partial SN2 may also occur)

   (b) 1-bromobutane + KOH → Butan-1-ol

   2-bromobutane + KOH → Butan-2-ol

   (c)1-bromobutane (SN2): leads to inversion of configuration

   2-bromobutane (SN1): leads to racemic mixture (equal enantiomers)

2. (a) In the stratosphere, UV radiation breaks C–Cl bonds in CFCs, releasing Cl· radicals.Cl· reacts with ozone (O_3), converting it to O_2 and forming ClO·, depleting the ozone layer:

$$Cl\cdot\ +O_3 \rightarrow ClO\cdot\ +O_2\ ClO\cdot\ +O \rightarrow Cl\cdot\ +O_2\ Cl\cdot + O_3 \rightarrow ClO\cdot + O_2\ \ ClO\cdot + O \rightarrow Cl\cdot + O_2$$

(b) Alternative: HCFCs (Hydrochlorofluorocarbons) or HFCs (Hydrofluorocarbons)

Advantage: They degrade faster and have less ozone-depleting potential.

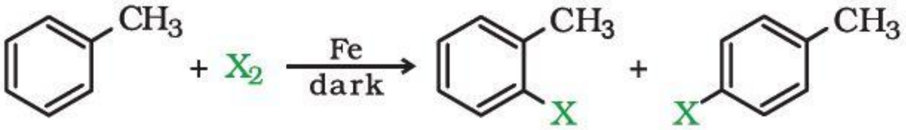
(c) Freon-12 is a haloalkane, not a haloarene, as it is derived from methane

(no aromatic ring).

3. (a) The reaction is called the Finkelstein reaction.
(b) Acetone is a polar aprotic solvent. It dissolves NaI but not NaBr, causing precipitation of NaBr, which drives the reaction forward (Le Chatelier's Principle).
(c)

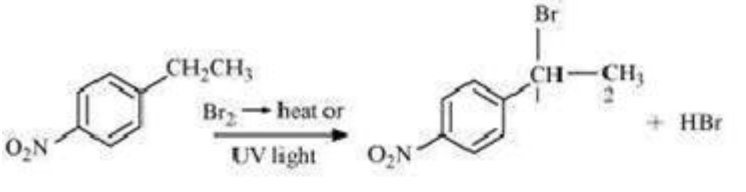
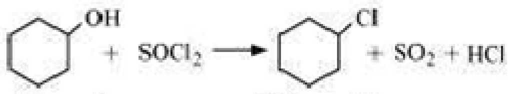
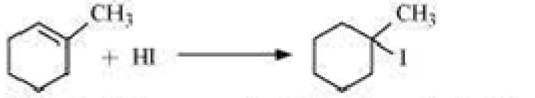
$$C_2H_5Br + NaI \xrightarrow{acetone} C_2H_5I + NaBr\downarrow$$

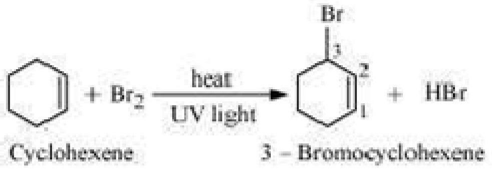
4.



o-Halotoluene *p*-Halotoluene

5.

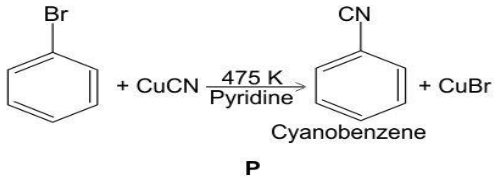
 4 – Hydroxymethylphenol 4 – Chloromethylphenol
 4 – Ethylnitrobenzene 4 – (1 – Bromoethyl) nitrobenzene
 Cyclohexanol Chlorocyclohexane
 1 – Methylcyclohexene 1 – Iodo – 1 – methylcyclohexane

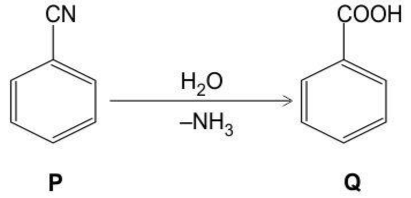


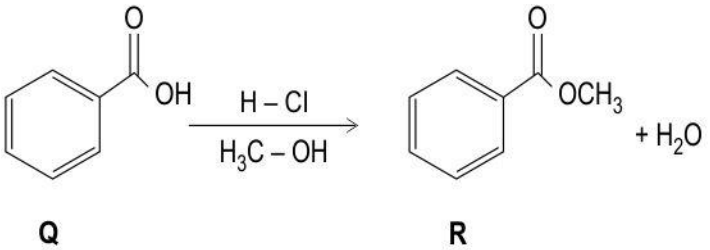
$CH_3CH_2Br + NaI \longrightarrow CH_3CH_2I + NaBr$

Bromoethane Iodoethane

6. It forms phenol: $C_6H_5Cl + NaOH \rightarrow C_6H_5OH + NaCl$ (at 623 K, 300 atm)
7. In the presence of peroxides, HBr adds to alkenes via free radical mechanism following anti-Markovnikov's rule, resulting in the halogen attaching to the less substituted carbon.
8. (a) prop-1-ene --→ bromopropane --→ 1-fluoroprpane
   (b) friedel craft alkylation
   (c) ethanol → ethylchloride → ethylcyanide
9. (a) The inductive effect (-I) is stronger than the resonance effect (+R) for chlorine.
   (b) The nitro group ($-NO_2$) at the ortho and para positions of a molecule enhances reactivity in nucleophilic substitution reactions by stabilizing the negative charge that develops during the reaction
10. (a) Chlorobenzene with CH_3COCl and $AlCl_3$: This is a Friedel-Crafts acylation.
    (b) Chlorobenzene with CH_3Cl and $AlCl_3$: This is a Friedel-Crafts alkylation.
    (c) Bromobenzene with CH_3Cl and $AlCl_3$: This is also a Friedel-Crafts alkylation.
11. i)The rate of the reaction can be improved by precipitating NaCl in dry acetone.
    ii)The reactants needed to prepare methyl fluoride is methyl chloride or methyl bromide and any metallic fluoride such as AgF, Hg_2F_2 , CoF_2 or SbF_3.
    iii) The decreasing order of their dipole moment is: methyl fluoride> methyl chloride > methyl iodide.
12.







CASE STUDY QUESTIONS (4 MARKS)

1. The replacement of hydrogen atom in a hydrocarbon, aliphatic or aromatic results in the formation of haloalkanes and haloarenes respectively. Haloalkanes contain halogen atom attached to sp3 hybridised carbon atom of an alkyl group whereas haloarenes contain halogen atom attached to sp2 hybridised carbon atom of an aryl group. Haloalkanes and haloarenes may be classified on the basis of number of halogen atoms in their structures as mono, di or poly halogen compounds and also on the basis of the state of hybridisation of carbon atom to which the halogen atom is bonded.

   (a) Give example of a 2°halide.
   (b) Write example of a Gem-dibromide.
   (c) Write the IUPAC name of $(CH_3)_3CCl$.

   or

   Write example of an allylic halide?

2. Everyone is aware of DDT a common pesticide. Did you Know DDT was sold as a wonder chemical post World War II ? It is because it was a very simple solution for all sorts of pest problems, be it small or large. It was in widespread use as a pesticide. DDT is nothing but a polyhalogen compound. Polyhalogen compounds have a wide variety of usage. Polyhalogen are carbon compounds having more than one halogen atom.Common use of polyhalogens are in agriculture and industrial sectors.

   a. Does DDT cause air pollution?
   b. Which polyhalogen compound is used as fire extinguisher?
   c. What is the use of Freon?

   or

   What is the use of BHC?

3. A student performed a nucleophilic substitution reaction between 2-bromopropane and aqueous KOH and observed the formation of alcohol. The teacher asked the class to identify whether the reaction followed SN1 or SN2 mechanism. The class learned that tertiary halides prefer SN1 due to carbocation stability, while primary halides follow SN2 due to lesser steric hindrance.

   (a)Which type of solvent favors the SN1 reaction?
   (b) In the above SN1reaction which intermediate is formed?
   (c) Why do tertiary alkyl halides undergo SN1 and not SN2?

   OR

   Racemic mixtures are formed in SN1 . Explain with example

4. The polarity of C X bond of alkyl halides is responsible for their nucleophilic substitution, elimination and their reaction with metal atoms to form organometallic compounds. Alkyl halides are prepared by the free radical halogenation of alkanes, addition of halogen acids to alkenes, replacement of OH group of alcohols with halogens using phosphorus halides, thionyl chloride or halogen acids. Aryl halides are prepared by electrophilic substitution of arenes. Nucleophilic substitution reactions are categorised into SN1 and SN2 on the basis of their kinetic properties.Chirality has a profound role in understanding the SN1 and SN2 mechanism.

   Answer the following questions :
   (i) What happens when bromobenzene is treated with Mg in the presence of dry ether ?
   ii) Which compound in each of the following pairs will react faster in SN1 reaction with OH ?
   (1) $CH_2 = CH\ CH_2\ Cl$ or $CH_3\ CH_2\ CH_2\ Cl$
   (2) $(CH_3)_3C\ Cl$ or CH_3Cl
   iii) Write the equations for the preparation of 1-iodobutane from
   (1) 1-chlorobutane
   (2) but-1-ene.

ANSWERS

Ans1 a) Isopropyl chloride
b) $CH_3CBr_2CH_3$
c) 2-Chloro-2-methylpropane

or

c) 4-Bromobut-1-ene

Ans2. a) No

(b) Tetrachloromethane

(c) Refrigerant

or

(c) Pesticide

Ans 3 (a) polar protic solvent

(b) carbocation intermediate

(c) 3^0 form stable carbocation

Or

Racemic mixtures have d- and l- both configurations

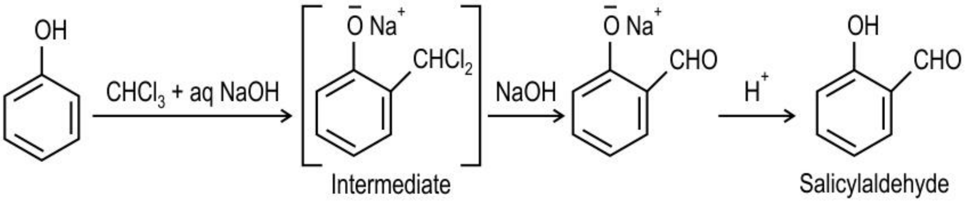
Ans 4

LONG ANSWER QUESTIONS (5 MARKS)

1. A compound 'A' with molecular formula$C_4H_{10}O$ is unreactive towards sodium metal. It does not decolourise Bromine water and does not react with $NaHSO_3$ solution. On refluxing 'A' with excess of HI gives 'B' which react with aq. NaOH to form 'C'. 'C' can be converted into 'B' by reacting with P and I_2 . 'C' on heating with conc.H_2SO_4 forms 'D' which decolorizes bromine water. Identify A to D and write the reactions involved.
   Hints: A diethylether, B ethyliodide, C ethanol, D ethene
2. (a) What are ambident nucleophiles? Explain with an example.
   (b) Haloalkanes easily dissolve in organic solvents, why?
   (c) Why chloroform is stored in completely filled closed dark coloured bottles?
   (d) Of the two bromo derivatives, $C_6H_5CH(CH_3)Br$ and $C_6H_5CH(C_6H_5)Br$, which one is more reactive in SN1 substitution reaction and why?
   Hints. (a) bonds at two or more spots in its structure,
   (b) haloalkanes and solvent molecules have similar intermolecular interactions.
   (c) oxidized by air in the presence of light
   (d) SN1 reactions increases as the stability of intermediate carbocation increases.
3. (a) Thionyl chloride method is preferred for preparing alkyl chlorides from alcohols.
   (b) Alkyl halides, though polar, are immiscible with water. Explain
   (c) Grignard's reagents should be prepared under anhydrous conditions, why?
   (d)The dipole moment of chlorobenzene is lower than that of cyclohexyl chloride. Explain
   (e) Which compound in each of the following pair will react faster in SN1 reaction with OH^- and why ?
   $(CH_3)_3CCl$ or $CH_3CH_2CH(Cl)CH_3$
   Hints. (a) The byproducts SO_2 and HCl being gases escape into the atmosphere leaving behind alkyl chlorides in almost pure state.
   (b) intermolecular hydrogen bonds with water molecules.
   (c) reacting with moisture.
   (d) lower magnitude of negative charge on Cl atom and shorter C—Cl bond
   (e) tertiary alkyl halide and produce more stable carbocation intermediate.

ALCOHOLS, PHENOLS AND ETHERS
MULTIPLE CHOICE QUESTIONS

1	Which of the following compounds can be used in the preparation of ethanol by hydroboration-oxidation? A. Ethene B. Ethyne C. Acetylene D. Methane
2	Which of the following reactions does not involve a carbocation intermediate? A. Dehydration of alcohol B. Reaction of alcohol with $HCl/ZnCl_2$ C. Conversion of alcohol to alkyl halide using $SOCl_2$ D. Reaction with Lucas reagent
3	Which of the following is least soluble in water? A. Methanol B. Ethanol C. n-Butanol D. n-Hexanol
4	In acidic medium, the reaction of primary alcohol with potassium dichromate leads to the formation of: A. Alkene B. carboxylic acid C. Ester D. Ether
5.	The boiling points of four compounds, an ether, an aldehyde, an alcohol, and a haloalkane of comparable molecular weights, are given (not necessarily in the same order) in the table below. Compound Boiling point P 35 °C Q 76 °C R 47 °C S 118 °C Identify which of the four compounds is the alcohol. A. P B. Q C. R D. S
6	The cleavage of C–O bond in ethers takes place more easily with: A. Dry HCl B. Aqueous H_2SO_4 C. HI or HBr D. HNO_3
7.	What is the product formed when phenol is treated with NaOH followed by CO_2 and then acidified? A. Anisole B. Benzoic acid C. Salicylic acid D. Benzaldehyde
8.	Which of the following does not have intermolecular hydrogen bonding in liquid state? A. Ethanol B. Phenol C. Diethyl ether D. Water
9.	The Lucas test helps distinguish between alcohols based on: A. Their acidity B. Their boiling point C. Rate of formation of alkyl halide D. Their molecular weight
10	In the reaction: $C_2H_5OH + CH_3COOH \rightarrow X + H_2O$, the compound 'X' is: A. Ethanoic acid B. Ethyl ethanoate C. Acetaldehyde D. Acetic anhydride
11	Methoxy methane on treatment with excess hydrogen iodide yields A. methanol as the only product. B. an equimolar mixture of methyl iodide and methanol C. methyl iodide as the only product D. methanol as the major product with a little methyl iodide

12	The pKa of phenol is lower than that of ______________which is a ________acid than phenol. A. ethanol, weaker B. *o*-cresol, stronger C. *m*-nitrophenol, weaker D. p-nitrophenol, stronger
13	On oxidation, an alcohol gave a product X which reduced Tollens' reagent. Which of the following could the alcohols be? P) $CH_3 - CH_2 - CH_2OH$ Q) $CH_3 - CH_2 - CHOH - CH_3$ R) $CH_3 - CH_2 - C(CH_3)_2 - OH$ A. only P B. only P or Q C. only Q or R D. any of P, Q or R
14	Identify the electrophile in the following reaction.  A. $^-CCl_3$ B. $:CCl_2$ C. $^+CHCl_2$ D. ^+CHO

ANSWER KEY:-

1	2	3	4	5	6	7	8	9	10
A	C	D	B	D	C	C	C	C	B
11	**12**	**13**	**14**						
C	A	A	B						

ASSERTION REASON QUESTIONS

For each question below, choose the correct option:

a) Both Assertion (A) and Reason (R) are true, and R is the correct explanation of A.
b) Both A and R are true, but R is not the correct explanation of A.
c) A is true, but R is false.
d) A is false, but R is true.

1. **Assertion (A):** Tertiary alcohols do not undergo oxidation easily.
   Reason (R): Oxidation of tertiary alcohols requires breaking of C–C bonds, which is difficult.
2. **Assertion:** Phenol reacts with aqueous bromine to form 2,4,6-tribromophenol.
   Reason: The –OH group activates the benzene ring towards electrophilic substitution by releasing electrons through resonance.
3. **Assertion (A):** The dehydration of alcohol is acid catalyzed.
   Reason (R): Acid protonates the –OH group making it a better leaving group.
4. **Assertion (A):** Ethanol shows a positive Lucas test at room temperature.
   Reason (R): Ethanol does not form a stable carbocation with Lucas reagent.
5. **Assertion (A):** Ether cleavage with HCl is faster than with HI.
   Reason (R): Iodide ion is a better nucleophile than chloride ion.

Answer key

1	2	3	4	5
a	a	a	d	d

2 MARK QUESTIONS

1. Arrange the following in increasing order of boiling points and also give reasons for the same:-
Ethanol, Methanol, Dimethyl ether
Hint: H-bonding & molecular mass

2. Explain – (a) why phenol is acidic but cyclohexanol is not, though both have –OH group attached to a ring.
(b) The C-O bond is much shorter in phenol than in ethanol. Give reason
Hint: (a) stability of phenoxide ion (b) The carbon of C-O bond of the phenol is sp^2 hybridised hence acquires a partial double bond character but in ethanol, it is sp^3 hybridized which is a single bond

3. Identify the major product formed when 2-methylpropan-2-ol is heated with conc. H_2SO_4. Write chemical equations.
Hint: Dehydration product

4. A compound 'X' with molecular formula C_3H_8O gives a clean oxidation to an acid with the same number of carbon atoms.
a) Identify compound X.
b) Write the reaction involved**.**

5. How will you obtain ethanol from ethyl magnesium bromide (C_2H_5MgBr)?
Hint: Use formaldehyde

6. Write the name and structure of the product formed when ethanol reacts with acetic acid in the presence of conc. H_2SO_4.
Hint: Ester

7. Give reasons:-
(a) The C-O-H bond angle in alcohols is slightly less than the tetrahedral angle.
(b) In methoxymethane C-O-H bond angle is slightly greater than the tetrahedral angle

8. How would you obtain phenol from:
a) Benzene b) Aniline
(Write reactions)

9. Identify A and B in the following reaction:
$C_2H_5OH + PCC \rightarrow A$
$A + CH_3MgBr \rightarrow$
Hint : Aldehyde & Ketone

10. Explain why anisole undergoes electrophilic substitution more easily than benzene.
Hint : Activating group

3 MARK QUESTIONS

1. Etherial solution of an organic compound ‘X’ when heated with Mg gave ‘Y’. ‘Y’ on treatment with ethanal followed by acid hydrolysis gave 2-propanol. Identify the compound ‘X’. What is ‘Y’ known as ?

Hint: Grignard reagent

2. Account for the following :
(a) Phenol has a smaller dipole moment than CH_3 OH.
(b) Phenol do not give protonation readily.
(c) Phenol is less acidic than carboxylic acid.
Hint : a) less polarity of C-O bond in phenol
b) delocalisation of lone pair
c) compare resonating structures

3. Name the reagents which are used in the following conversions :
(i) 1° alcohol to an aldehyde
(ii) Butan-2-one to butan-2-ol
(iii) Phenol to 2, 4, 6 tribromophenol
Hint : PCC , LiAlH4, Br2 water

4. Write structures of the major products of the following :

(i) Mononitration of 3-methylphenol

(ii) Phenol with CO2 in presence of alkali followed by acidfication

(iii) Mononitration of phenyl methanoate

Hint: Nitrating mixture, Kolbe’s reaction, nitrating mixture

5. Give equations of the following reactions :

(i) Oxidation of propan-1-al with alkaline KMnO4 solution.

(ii) Bromine in CS2 with phenol.

(iii) Treating phenol with chloroform in presence of aqueous NaOH.

Hint: aldehyde, monobromo compound, Reimer Tiemann reaction

6. Two compounds (A) and (B) have same molecular formula $C_4H_{10}O$. Both react with Na metal to liberate H_2 gas. Compound (A) gives yellow ppt when reacted with I_2 in NaOH but compound (B) does not respond to I_2 in NaOH. Identify (A) and (B) . Write the chemical reaction involved.

Hint: (A) Butan-2-ol (B)2- methyl propan-2-ol

---

7. Dehydration of alcohols to form an alkene is always carried out with conc. H2SO4 and not with conc. HCl or HNO3 . Explain.

Hint: Write mechanism

8. How will you convert :

(i) Phenol to cyclohexanol

(ii) Benzyl chloride to benzyl alcohol

(iii) Anisole to phenol

Hint: H2/Ni, aq. NaOH, HI

9. Arrange the following in the order of increasing acidic strength and justify:

a) p-nitrophenol, phenol, p-methylphenol

b) CH_3CH_2OH, H_2O, C_6H_5OH

c) Phenol, ethanol, benzoic acid

Hint: compare stability of anion after loss of proton

10. Explain why phenol undergoes electrophilic substitution more readily than benzene. Give two examples of such reactions with equations.

Hint: give resonating structures

11. An alcohol has the formula $C_5H_{11}OH$. Draw the structural formulae of any one of its isomers that is:

i) a primary alcohol and has a IUPAC name based on propane

ii) a secondary alcohol and has a IUPAC name based on butane

iii) a tertiary alcohol

Hint: draw isomers of $C_5H_{11}OH$

12. To prepare n-propyl ethyl ether, Kavita heats a mixture of n-propyl alcohol and ethyl alcohol in the presence of concentrated sulphuric acid.

Is this a good method to prepare the product? Give reasons to your answer.

Hint: This is not a good method for the preparation of n-propyl ethyl ether.

The reaction will produce a mixture of three different ethers which would be difficult to separate.

13. Organic compound 'A', having the molecular formula C_3H_8O on treatment with Cu at 573 K, gives B'. 'B' does not reduce Fehling's solution but gives a yellow precipitate of the compound 'C' with I_2/NaOH. Deduce the structures of A, B and C.

Hint: A propan -2- ol, B- propanone C Iodoform

CASE BASED QUESTIONS

1. Acidity refers to the tendency of a compound to donate a proton (H^+). In organic compounds, the acidity depends on the stability of the conjugate base formed after

deprotonation. Alcohols (like ethanol), phenols (like C_6H_5OH), and carboxylic acids (like CH_3COOH) all have –OH groups, but differ significantly in their acidic strength. Carboxylic acids are the most acidic due to resonance stabilization of the carboxylate ion and the electron-withdrawing nature of the carbonyl group. Phenols are less acidic than carboxylic acids but more acidic than alcohols, because the phenoxide ion is resonance-stabilized. Alcohols, with alkyl groups that donate electrons, are the least acidic.
The acidity order is:
Carboxylic acid > Phenol > Alcohol

Answer the following questions:

(i) Arrange the following in increasing order of acidity and justify:
Ethanol, Phenol, Acetic acid
(ii) Why is phenol more acidic than ethanol? Explain with resonance structures.
(iii) Explain why carboxylic acids are stronger acids than phenol.
(iv)What will happen when each of the three – ethanol, phenol, and acetic acid – is added to sodium bicarbonate ($NaHCO_3$)?

Hint: compare acidic behaviour considering the stability of ions formed by losing proton.

2. Ethanol undergoes dehydration in the presence of concentrated H_2SO_4 at 443 K to form ethene. This reaction proceeds via a carbocation intermediate and is classified as an E1 elimination reaction. It is important in the industrial preparation of alkenes.

Answer the following:
(i) Write the complete mechanism for the dehydration of ethanol.
(ii) Why is concentrated H_2SO_4 used in the reaction?
(iii) Predict the major product when 2-methylbutan-2-ol is dehydrated.
Hint: H_2SO_4 as dehydrating agent, Saytzeff rule

3. A chemistry teacher demonstrated Lucas Test to help students distinguish between primary, secondary, and tertiary alcohols. She took three test tubes labelled A, B, and C, each containing a different alcohol: propan-1-ol, propan-2-ol, and 2-methylpropan-2-ol.
She added Lucas reagent (conc. HCl + anhydrous $ZnCl_2$) to each test tube and recorded the time taken for turbidity to appear:

Test Tube	Alcohol	Time for Turbidity
A	Propan-1-ol	No turbidity at room temp
B	Propan-2-ol	Turbidity in 5–8 minutes
C	2-methylpropan-2-ol	Immediate turbidity

The class was asked to identify the type of alcohol in each test tube and explain the differences in behaviour based on carbocation stability and reaction mechanism.

Answer the following questions:
(i) Identify which test tube contains 1°, 2°, and 3° alcohols.
(ii) Explain why turbidity appears immediately in test tube C but not in A.
(iii) Write the chemical equation for the Lucas test with propan-2-ol.
(iv) What type of reaction mechanism does the Lucas test follow? Why is it suitable here?

Answer:
(i)
- Test tube A: Propan-1-ol (1° alcohol)
- Test tube B: Propan-2-ol (2° alcohol)
- Test tube C: 2-methylpropan-2-ol (3° alcohol)

(ii) 3° alcohol (C) forms a stable carbocation instantly → fast SN1 reaction → immediate turbidity.
1° alcohol (A) forms unstable carbocation → no turbidity at room temperature.
(iii)$CH_3CH(OH)CH_3 + HCl \rightarrow CH_3CH(Cl)CH_3 + H_2O$ (in presence of $ZnCl_2$)
(iv) SN1 mechanism – suitable for 2° and 3° alcohols because the intermediate carbocation is stable. The rate-determining step is carbocation formation.

4. Phenols undergo electrophilic substitution reactions readily due to the strong activating effect of OH group attached to the benzene ring. Since, the OH group increases the electron density more to o- and p- positions therefore OH group is ortho, para-directing. Reimer-Tiemann reaction is one of the examples of aldehyde group being introduced on the aromatic ring of phenol, ortho to the hydroxyl group. This is a general method used for the ortho-formylation of phenols.

Answer the following questions :
(a) What happens when phenol reacts with
1) Br_2/CS_2
(ii) Conc. HNO_3
(b) Why phenol does not undergo protonation readily?
Which is a stronger acid - phenol or cresol? Give reason.

OR

(e) Write the IUPAC name of the product formed in the Reimer Tiemann reaction.
Hint :- Proper reactions

5 MARK QUESTIONS

1. An ether A ($C_5H_{12}O$) when heated with excess of hot concentrated HI produced two alkyl halides which on hydrolysis form compounds B and C. Oxidation of B gives an acid D whereas oxidation of C gives a ketone E. Deduce the structures of A, B, C, D, and E.

Answer- A = $CH_3CH_2–O–CH(CH_3)_2$, B = CH_3CH_2OH, C = $(CH_3)_2CHOH$
D = CH_3COOH, E = CH_3COCH_3

2. A student is given three alcohols:
A: Propan-1-ol, B: Propan-2-ol, C: 2-methylpropan-2-ol
He is asked to perform Lucas Test and Iodoform Test to identify them.
(a) Arrange A, B, and C based on Lucas Test reactivity and explain the reason.
(b) Which alcohol will give a positive iodoform test? Write the reaction.
(c) Which of the three is most acidic and why?
Hint:$3^o > 2^o > 1^O$

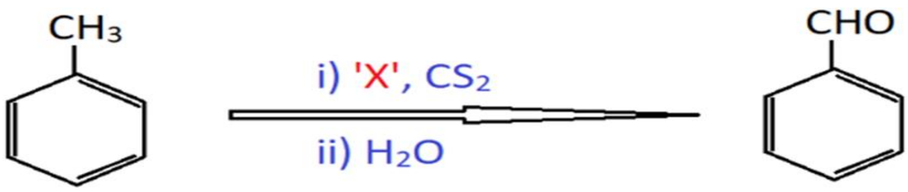
3. An alcohol A ($C_4 H_{10}O$) on oxidation with acidified $K_2Cr_2O_7$ gives carboxylic acid B ($C_4 H_8 O_2$). Compound A when dehydrated with conc. H_2SO_4 at 443 K gives compound C with aqueous H_2SO_4. C gives compound D ($C_4 H_{10}O$) which is an isomer of A. Compound D is resistant to oxidation but compound A can be easily oxidized. Identify A, B, C and D and write their structure and write the chemical equations involved.
Ans. A : $(CH_3)_2CH_2CH_2OH$, B : CH3 $CH(CH_3)COOH$,
C : $(CH_3)_2 C = CH_2$ D : $(CH_3)_3COH$

4. An organic compound 'A', molecular formula C_2H_6O oxidises with CrO_3 to form a compound 'B'. Compound 'B' on warming with iodine and aqueous solution of NaOH gives a yellow precipitate of compound 'C'. When compound 'A' is heated with conc. $H_2 SO_4$ at 413 K gives a compound 'D', which on reaction with excess HI gives compound E'. Identify compounds 'A', B', 'C', D' and 'E' and write chemical equations involved.

Hint: A Ethanol B. Ethanal. C. Iodoform. D Methoxy methane. E methyl iodide

ALDEHYDES, KETONES & CARBOXYLIC ACIDS

MULTIPLE CHOICE QUESTIONS

1.	Which of the following methods cannot produce aldehydes? a) Oxidation of primary alcohols b) Dehydrogenation of secondary alcohols c) Ozonolysis of alkenes d) Hydration of ethyne with acid
2.	Which of the following reactions can produce ketones? a) Oxidation of primary alcohols b) Dehydrogenation of primary alcohols c) Dehydrogenation of tertiary alcohols d) Oxidation of secondary alcohols
3.	Conversion of Propyne to acetone requires three important reagents. Identify which of the following is not one of the three? a) Water b) Zinc dust c) H_2SO_4 d) $HgSO_4$
4.	What is the catalyst used in the hydrogenation of acetyl chloride to produce Ethanal? a) Pt over $BaSO_4$ b) Pt over $CuSO_4$ c) Pd over $BaSO_4$ d) Pd over CuSO4
5.	Which of the following carbonyl compounds can be prepared from the Rosenmund reaction? a) Methanal b) Acetone c) Butanone d) Benzaldehyde
6.	Which of the following is required in Stephen's reaction? a) LiCl b) $NiCl_2$ c) $SnCl_2$ d) $TiCl_4$
7.	Which of the following compounds helps in reducing esters to aldehydes? a) BINAL-H b) DIBAL-H c) DIPT d) TBAF
8.	Identify 'X' in the reaction given below:  a) CrO3 b) CrO_2Cl_2 c) Alkaline $KMnO_4$ d) Anhydrous $AlCl_3$
9.	The reagent which does not react with both acetone and benzaldehyde a)Sodium hydrogen sulphite b)Phenyl hydrazine c)Fehling solution d)Grignard reagent
10	In Clemmensen's Reduction, carbonyl compound is treated with ___________. (a) Zn-Hg amalgam + HCl (b) Na-Hg amalgam + HCl (c) Zn-Hg amalgam + HNO_3 (d) Na-Hg amalgam + HNO_3

Q.NO.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
ANS	B	D	B	C	D	C	B	B	C	A

ASSERTION-REASON

Select the correct answer to these questions from the codes (A), (B), (C) and (D) as given below:

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion

(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).

(C) Assertion (A) is true, but Reason (R) is false.

(D) Assertion (A) is false, but Reason (R) is true.

1. **Assertion (A)** : The solubility of aldehydes and ketones in water decreases with increase of size of the alkyl group.
   Reason (R) : Alkyl groups are electron releasing groups

2. **Assertion (A):** Oxidation of ketones is easier than aldehydes
   Reason (R) : C-C bond of ketones is stronger than C-H bond of aldehydes

3. **Assertion (A**) : PKa of acetic acid is lower than that of phenol.
   Reason (R) : Phenoxide ion is more resonance stabilize that acetate ion.

4. **Assertion(A**) : Methanal, Ethanal and Propanone are miscible with water in all proportions.
   Reason (R): The lower members of aldehydes and ketones form hydrogen bonds with water.

5. **Assertion(A**) :Acetic acid is miscible with water in all proportions.
   Reason (R): Acetic acid can form hydrogen bonds with water molecules

Q.NO.	**1**	**2**	**3**	**4**	**5**
ANS	B	D	C	A	A

SHORT ANSWER QUESTIONS TWO MARKS

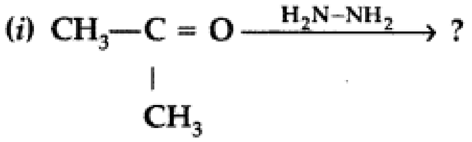
1. Write the chemical equation when:
   (a) Butan-2-one is treated with Zn(Hg) and conc. HCl.
   (b) Two molecules of benzaldehyde are treated with conc. NaOH.
2. Write the chemical equations when
   (a) Ethanal is treated with 2,4-dinitrophenylhydrazine ?
   (b) Propanone is treated with Zn(Hg) and conc. HCI?
3. Account for the following:
   (a) Oxidation of aldehydes is easier as compared to ketones.
   (b) The alpha (α) hydrogen atoms of aldehydes are acidic in nature.
4. Draw structures of the following derivatives:
   (i) The 2,4-dinitrophenylhydrazone of benzaldehyde
   (ii) Cyclopropanone oxim
5. Give reason
   a) Why does benzoic acid not undergo Friedel-Craft reaction?
   b) Why is the Pka of $F\text{-}CH_2COOH$ lower than that of $Cl–CH_2COOH$?
6. Convert -:
   a) Phenyl magnesium bromide to benzoic acid?

b) Benzoic acid to Sulphanilic acid

7. Which of the following compounds would undergo aldol condensation, which the Cannizzaro reaction & which is neither? Write the structures of the expected products of aldol condensation and Cannizzaro reaction-: (i) Methanal (ii) 2-Methylpentanal (iii) Benzaldehyde (iv) Benzophenone
8. How will you convert ethanal into the following compounds?
   (i) But-2-enal (ii) But-2-enoic acid
9. Give plausible explanation for each of the following:
   (i) Why does phenol have higher Pk_a value than carboxylic acids?
   (ii) How will you convert cyanide to aldehyde?

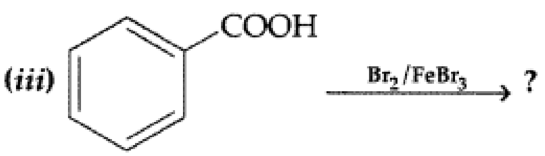
SHORT ANSWER QUESTIONS -3 MARKS

1. Predict the products of the following reactions:



$(i)\ \underset{\displaystyle CH_3}{\underset{|}{CH_3-C}} = O \xrightarrow{H_2N-NH_2} ?$

$(ii)\ C_6H_5-CH_3 \xrightarrow[(b)\,H^+]{(a)\,KMnO_4/KOH} ?$



2. Write the equations involved in the following reactions:
   a) Stephens reaction b) Etard Reaction c) Popoff's rule
3. Write structures of compounds A, B and C in each of the following reactions-:

$$CH_3CN \xrightarrow[(b)\,H_3O^+]{(a)\,SnCl_2/HCl} A \xrightarrow{\text{dil. NaOH}} B \xrightarrow{\Delta} C$$

4. Do the following conversions in not more than two steps:
   (i) Benzoic acid to Benzaldehyde
   (ii) Ethylbenzene to Benzoic acid
   (iii) Propanone to Propene

5. a) How will you convert pentanenitrile into hexan-2-one using Grignard reagent?
b) How will you prepare α-halo acids ?Name the reaction.

6. (i) Give a simple chemical test to distinguish between Pentan-3-one and Propanone.
(ii) What happens when :
(a) Butanone is treated with Methyl Magnesium bromide and then hydrolysed.
(b) Sodium benzoate is heated with soda lime?

7. An organic compound A ($C_2H_4O_2$) reacts with $NaHCO_3$ to give effervescence. A gives a fruity smell when treated with ethanol in presence of conc. H_2SO_4
(a) Identify compound A.
(b) Write the reactions involved.
(c) Name the functional group present in A.

8. Write the chemical reactions involved in the following tests:
(a) Tollen's test for aldehydes (b) Fehling's test (c) Iodoform test with acetone

9. Account for the following-:
(a) Formaldehyde does not take part in Aldol condensation.
(b) Benzaldehyde does not respond to Fehling Test
(c) Give Chemical equation involved in Gattermann – Koch reaction

10. Write the structures of the following compounds.
(i) α-Methoxy Propionaldehyde
(ii) 2-Hydroxycyclopentane carbaldehyde
(iii) Di-sec. butyl ketone

11. 'A' and 'B' are two functional isomers of compound C4H8O. On heating with NaOH and I_2, isomer 'B' forms yellow precipitate of iodoform whereas isomer 'A' does not form any precipitate.

(i) Identify 'A' and 'B'.

(ii) What happens when isomer 'A' is treated with Zn(Hg) in the presence of Conc. HC*l* ?

(iii) Write the reaction of isomer 'B' with NaOH and I_2.

Hint: A: Butanal B : butane-2-one

12. An organic compound (X) having molecular formula $C_5H_{10}O$ can show various properties depending on its structures. Draw each of the structures if it :

(I) shows Cannizzaro reaction. 1

(II) reduces Tollens' reagent and has a chiral carbon. 1

(III) gives positive iodoform test.

Hint:- Draw different isomers of $C_5H_{10}O$ and identify above properties

13. Organic compound 'A', having the molecular formula C_3H_8O on treatment with Cu at 573 K, gives B'. 'B' does not reduce Fehling's solution but gives a yellow precipitate of the compound 'C' with I_2/NaOH. Deduce the structures of A, B and C.

Hint:- A. Propan -2 ol B. Propan -2- one C Iodoform

14. An alkene with molecular formula C5H10 on ozonolysis gives a mixture of two compounds 'B' and 'C'. Compound B' gives positive Fehling test and also reacts with iodine and NaOH solution. Compound 'C' does not give Fehling solution test but forms iodoform. Identify the compounds 'A', B' and 'C'.

CBQ- 4 MARKS EACH

1. A chemist treats a compound (A) with 2,4-DNP reagent and gets a yellow-orange precipitate. On treatment with Tollen's reagent, a silver mirror is formed. When (A) is heated with Fehling's solution, a brick-red precipitate is observed. Further, (A) on oxidation gives acetic acid.

   Answer these questions-:

   (i) What is compound (A)? Give its structure.
   (ii) Write the chemical equation of its reaction with Tollen's reagent.
   (iii) Does compound (A) give Iodoform test. Give reason for your answer?
   OR
   (iv) Name one test which can distinguish between (A) and Propanone.Write the reaction.

2. The carbon-oxygen double bond is polarised in aldehydes and ketones due to higher electronegativity of oxygen relative to carbon. Therefore, they undergo nucleophilic addition reactions with a number of nucleophiles such as HCN, $NaHSO_3$, alcohols ,ammonia derivatives and Grignard reagents. Aldehydes are easily oxidised by mild oxidising agents as compared to ketones. Carboxylic acids are considerably more acidic than alcohols and most of simple phenols.

   Answer the following :
   (a) Write the name of the product when an aldehyde reacts with excess alcohol in presence of dry HCl.
   (b) Why carboxylic acid is a stronger acid than phenol?
   (c) Arrange the following in decreasing order of acidic character .
   CH_3COOH $CH_2ClCOOH$ $CHCl_2COOH$
   OR
   (c) Out of acetic acid and benzoic acid which one is a stronger acid and why ?

3. A compound (P) with the molecular formula $C_4H_8O_2$ is found to be an ester. Upon hydrolysis, compound (P) gives two products: a carboxylic acid (Q) and an alcohol (R).The carboxylic acid (Q) on heating with soda lime gives methane. The alcohol (R) on oxidation gives the same carboxylic acid (Q).

(a) Identify compound (P), (Q), and (R), giving reasons for your answer.
(b) Write the balanced chemical equation for the hydrolysis of compound (P)?
(c) What is the IUPAC name of compound (P).Write its structure.
OR
(c)What is the name of the reaction between carboxylic acid and alcohol and which derivative is formed?

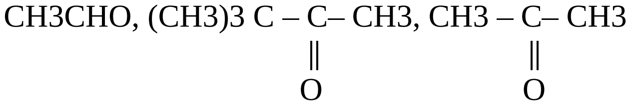
15. The carbon – oxygen double bond is polarised in aldehydes and ketones due to higher electronegativity of oxygen relative to carbon. Therefore they undergo nucleophilic addition reactions with a number of nucleophiles such as HCN, NaHSO3, alcohols, ammonia derivatives and Grignard reagents. Aldehydes are easily oxidised by mild oxidising agents as compared to ketones. The carbonyl group of carboxylic acid does not give reactions of aldehydes and ketones. Carboxylic acids are considerably more acidic than alcohols and most of simple phenols.

Answer the following :

(a) Write the name of the product when an aldehyde reacts with excess alcohol in presence of dry HC*l*. **1**

(b) Why carboxylic acid is a stronger acid than phenol ? **1**

(c) (i) Arrange the following compounds in increasing order of their reactivity towards CH_3MgBr :



CH3CHO, $(CH3)3\ C-\underset{\underset{O}{\|}}{C}-CH3$, $CH3-\underset{\underset{O}{\|}}{C}-CH3$

(ii) Write a chemical test to distinguish between propanal and propanone.

LAQ- 5 MARKS

1. a) Explain the mechanism of a nucleophilic attack on the carbonyl group of an aldehyde or a ketone.
(b) An organic compound (A) (molecular formula $C_6H_{16}O_2$) was hydrolysed with dilute sulphuric acid to give a carboxylic acid (B) and an alcohol (C). Oxidation of (C) with chromic acid also produced (B). on dehydration (C) gives but-1-ene. Write the equations for the reactions involved

2. Illustrate the following reactions giving a suitable example for each.
(a) Cross Aldol condensation (ii) Decarboxylation
(b) Give simple tests to distinguish between the following pairs of compounds -
(i) Pentan-2-one and Pentan-3-one (ii) Benzaldehyde and Acetophenone
(iii) Phenol and Benzoic acid

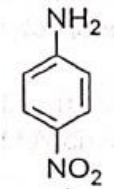
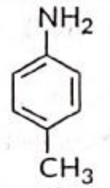
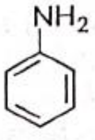
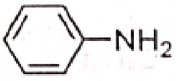
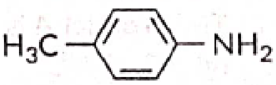
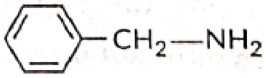
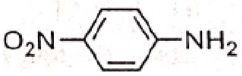
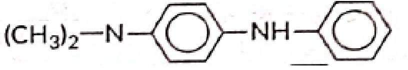
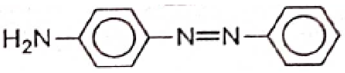
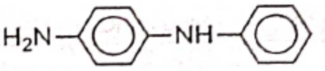
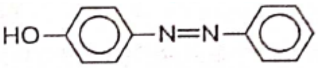
3. (a) Give a plausible explanation for each one of the following :
(i) There are two – NH_2 groups in Semicarbazide. However, only one such group is involved in the formation of Semicarbazones.
(ii) Cyclohexanone forms cyanohydrin in good yield but 2, 4, 6-trimethylcyclohexanone does not.
(b) An organic compound with molecular formula $C_9H_{10}O$ forms 2, 4, – DNP derivative, reduces Tollen's' reagent and undergoes Cannizzaro reaction. On vigorous oxidation it gives 1, 2-benzene-di- carboxylic acid. Identify the compound.

4. An organic compound 'A' with molecular formula $C_5H_8O_2$ is reduced to n-pentane with hydrazine followed by heating with NaOH and Glycol. 'A' forms a dioxime with hydroxylamine and gives a positive Iodoform and Tollen's test. Identify 'A' and give its reaction for Iodoform and Tollen's test.

5. Compound (A) ($C_6H_{12}O_2$) on reduction with $LiAlH_4$ gives two compounds (B) and (C). The compound (B) on oxidation with PCC gives compound (D) which upon treatment with dilute NaOH and subsequent heating gives compound (E). Compound (E) on catalytic hydrogenation gives compound (C). The compound (D) is oxidized further to give compound (F) which is found to be a monobasic acid (Molecular weight = 60). Identify the compounds (A), (B), (C), (D), (E) and (F).

AMINES (Level II)

(I) Multiple Choice Questions

1	Which of the following would not be a good choice for reducing nitrobenzene to aniline? (a) $LiAlH_4$ (b) H_2/Ni (c) Fe and HCl (d) Sn and HCl
2	Three compounds are given below:  I  II  III The correct decreasing order of their basic strength is (a) II > III > I (b) III > II > I (c) III > I > II (d) I > III > II
3	Among the following, which is the strongest base? (a)  (b)  (c)  (d) 
4	Ethyl amine can be prepared by the action of $LiAlH_4$ on (a) CH_3NO_2 (b) CH_3-CN (c) CH_3-NC (d) CH_3-CH_2-$CONH_2$
5.	In cold conditions, aniline is diazotized and then treated with aniline again to give a coloured product. The structure of the coloured product is (a)  (b)  (c)  (d) 
6	What is the product of the reaction between an alkyl halide and ammonia? a) Primary amine b) Secondary amine c) Tertiary amine d) All of the above
7	How can you distinguish between aniline and N-methylaniline? a) By carbylamine reaction b) By azo dye test c) By acetylation reaction d) By all of the above
8	What is the purpose of the Sandmeyer reaction? a) To prepare aryl halides from diazonium salts b) To prepare alkyl halides from diazonium salts c) To prepare amines from diazonium salts d) None of the above
9	Why is aniline less basic than aliphatic amines? a) Due to +I effect of the alkyl group b) Due to resonance effect of the phenyl group c) Due to steric hindrance d) Due to inductive effect
10	What is the product of the reaction between aniline and acetyl chloride? a) Acetanilide b) N-Methylaniline

	c) p-Aminoacetophenone d) Benzamide
11	Benzene sulphonyl chloride is a chemical which can be used to identify the class of an Amine. When an amine 'A' reacts with benzene sulphonyl chloride it gives precipitate of sulphonamides which is soluble in alkali. The amine A is; A. N-Ethylethanamine B. N,N-Diethylethanamine C. Ethanamine D. N-Methylbenzenamine
12	2-Methyl butanamide on reacting with Br_2 in alkaline medium gives an amine. Which of the following is a correct characteristic of that amine? A. It is optically active. B. It is a secondary amine. C. It can form a stable diazonium salt. D. It has one carbon atom more than the amide
13	Two isomers, n- $C_4H_9NH_2$ and $(C_2H_5)_2NH$ have molar mass of 73 each. Which of the following is correct about their boiling points? A. The boiling point of n- $C_4H_9NH_2$ is higher than that of $(C_2H_5)_2NH$. B. The boiling point of $(C_2H_5)_2NH$ is higher than that of n- $C_4H_9NH_2$. C. Both the amines will have the same boiling point. D. The boiling point of both the amines will be lower than that of water.
14	Which of the following sets have all the compounds with a pKb value more than ammonia? A. N, N-dimethylaniline, methylamine, ethanamine. B. aniline, N, N-dimethylaniline, N-methylaniline C. N,N-Dimethylmethanamine, Ethanamine, N, N-Diethylethanamine D. N-Diethylethanamine, ethanamine, Methanamine

Answers: 1. (c), 2. (a), 3. (b), 4. (b), 5. (b), 6. (d), 7. (a), 8. (a), 9. (b), 10. (a). 11. C 12. A 13. A. 14. B

(II) Assertion-Reason Type Questions

Select the most appropriate answer from the options given below:

(A) Both A and R are true and R is the correct explanation of A
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

1. **Assertion (A):** $(C_2H_5)_2NH$ is more basic than $(C_2H_5)_3N$ in aqueous solution.
   Reason (R): In $(C_2H_5)_2NH$, there is more steric hindrance and +I effect than $(C_2H_5)_3N$.
2. **Assertion (A):** Ammonolysis of alkyl halides is not a suitable method for the preparation of pure primary amines.
   Reason (R): Ammonolysis of alkyl halides yields mainly secondary amines.
3. **Assertion (A):** Monobromination of aniline can be conveniently done by protecting the amino group byacetylation.
   Reason (R): Acetylation decreases the activating effect of the amino group.
4. **Assertion (A):** Aromatic primary amines cannot be prepared by Gabriel Phthalimidesynthesis.
   Reason(R): Aryl halides do not undergo nucleophilic substitution reaction with the anion formed by phthalimide.

5. **Assertion (A):** Acetanilide is less basic than aniline.
   Reason (R) : Acetylation of aniline results in decrease of electron density on nitrogen.
6. **Assertion (A):** Boiling point of $(CH_3)_3N$ is higher than that of $CH_3CH_2CH_2NH_2$.
   Reason (R): Hydrogen bonding is more extensive in $CH_3CH_2CH_2NH_2$.
7. **Assertion (A):** Boiling point of $(C_2H_5)_2NH$ is lower than that of n-$C_4H_9NH_2$.
   Reason (R): Hydrogen bonding is much more extensive in n-$C_4H_9NH_2$ as compared to $(C_2H_5)_2NH$.
8. **Assertion (A):** Diazonium salts of aromatic amines are more stable than those of aliphatic amines.
   Reason (R): Diazonium salts of aliphatic amines show resonance.
9. **Assertion (A):** Aniline is a weaker base than cyclohexylamine.
   Reason (R): Aniline is resonance stabilized.
10. **Assertion (A):** Aniline does not undergo Friedel-Crafts reaction.
    Reason (R): Friedel-Crafts reaction is an electrophilic substitution reaction.

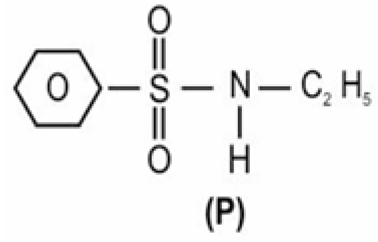
ANSWERS: 1. (C) 2. (C) 3. (A) 4. (A) 5. (A) 6.(D) 7. (A) 8. (C) 9. (A) 10. (B)

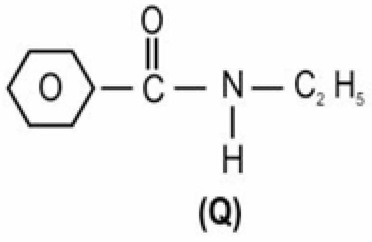
SHORT ANSWER QUESTIONS (2M)

1. A compound 'X' having molecular formula C_3H_7NO, reacts with Br_2 in presence of KOH to give another Compound 'Y'. The compound Y reacts with HNO_2 to form ethanol and N_2 gas. Identify the compound X and Y and write the reactions involved.
   (Hint: X = $CH_3CH_2CONH_2$; Y = $CH_3CH_2NH_2$)
2. Give an example of:
   (i) an amine each with basic strength greater than and less than N-Methylmethanamine in gaseous state.
   (ii) an isomeric amine each with boiling point less than and more than N-Ethylethanamine.
   Ans: (i) An amine with basic strength greater is N, N-Dimethylethanamine and less is methanamine (or any other correct option)
   (ii) An isomeric amine with boiling point less than the N-Ethylethanamine is N,N-Dimethylethan amine and more is Butanamine.
3. (i) Draw the zwitter ion structure for sulphanilic acid.
   (ii) How can the activating effect of $–NH_2$ group in aniline be controlled ?
   Ans: (i) From Book (ii) Protecting /deactivating $-NH_2$ group by acetylation or acylation.
4. Account for the following:
   (i) $(CH_3)_2NH$ is more basic than $(CH_3)_3N$ in aqueous solution.
   (ii) Methylamine in water reacts with $FeCl_3$ to precipitate hydrated ferric oxide.
   Ans: (i) Combination of inductive effect and solvation effect / Due to greater H-bonding with water molecules, $(CH_3)_2NH$ shows more hydration or solvation effect.
   (ii)Hint: Methyl amine being basic releases OH^- ions which react with Fe^{3+} ions.
5. Arrange the following compounds as asked:
   (i) $C_2H_5NH_2$, $(C_2H_5)_2NH$, $C_6H_5NHCH_3$, $C_6H_5NH_2$ (in decreasing order of pK_b values)
   (ii) C_2H_5OH, $C_2H_5NH_2$, $(CH_3)_2NH$ (increasing order of solubility in water)
6. (i) In a chemistry practical class, the teacher gave his students an amine ‘X’ having molecular formula C_2H_7N, and asked the students to identify the type of amine. One of the students, Neeta, observed that it reacts with $C_6H_5SO_2Cl$, to give a compound which dissolves in NaOH solution. Can you help Neeta to identify the compound ‘X’ ?
   (ii) Arun heated a mixture of ethylamine and $CHCl_3$ with ethanolic KOH, which forms a foul smelling gas. Write the chemical equation involved.
7. Complete the following reactions:
   (i) $C_6H_5NO_2 \xrightarrow{Fe+HCl} A \xrightarrow{Br2\ water} B$
   (ii) $A \xrightarrow{Br2+KOH} C_6H_5NH_2 \xrightarrow{C6H5COCl} B$

8. Prapti takes some aniline in a container. She adds to it, a mixture of sodium nitrite and hydrochloric acid at 0 - 5°C. She leaves the mixture beside an open window on a hot and sunny day. What will be the change in the composition of the reaction mixture? Why?
(hint: Unstable above 10°C.)

9. Of the two compounds P and Q given below, which one is more likely to be acidic in nature? Justify your answer.


(P)


(Q)

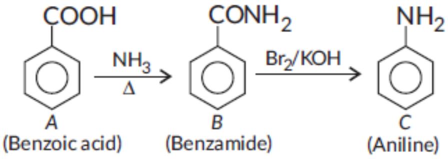
(Hint: P)

10. Write the structures of main products when benzene diazonium chloride reacts with the following reagents:
(i) $H_3PO_2 + H_2O$ (ii) CuCN/KCN (iii) KI (iv) H_2O

11. p-chlorobenzene diazonium chloride and p-methyl benzenediazonium chloride are taken in separate beakers. Now phenol and a few drops of NaOH is added to both the beakers.
Which of the two para-substituted diazonium compounds will couple preferentially with phenol to give a coloured dye? Explain why
(Hint:- p chloro due to its electron withdrawing nature)

Short Answer Type Questions (3 Marks)

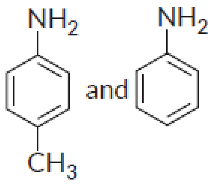
1. An aromatic compound 'A' ($C_7H_6O_2$) on reaction with aqueous ammonia and heating forms compound 'B'. "B' on heating with Br_2 and alcoholic potash forms a compound 'C' of molecular formula C_6H_7N. Write the reactions involved and identify 'A', 'B', 'C'.
Hint:-



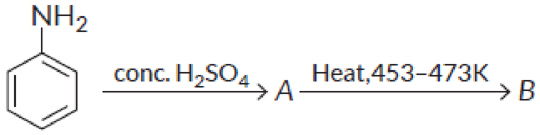
2. An amine M reacts with sulphuric acid at 473 K to form compound N. Amine M cannot be prepared by the Gabriel phthalimide synthesis. It is the simplest amine of its type.
a) Identify M and write its IUPAC name.
b) If electricity is passed through an aqueous solution of compound N and a bulb is connected to this circuit what will be your observation and why?
(Hint: a) Amine M is aniline]
b) If electricity is passed through an aqueous solution of compound N and a bulb is connected to this circuit then the bulb will not glow.

3. (i) Consider two unknown primary amine compounds A and B, one of which is aromatic and the other is aliphatic amine. Compound A reacts with $NaNO_2$ in HCl to give a useful diazonium compound. But amine B on reaction with $NaNO_2$ and HCl produces ethanol.
(a) Which of the two amines is aromatic and why?
(b) Give evidence to identify the amine B.
(ii) You are given three compounds of nitrogen having the general formula NH_2-X. If X= C_6H_6, CH_3 or H, which of the three compounds will be protonated MOST easily in water? Justify your answer.

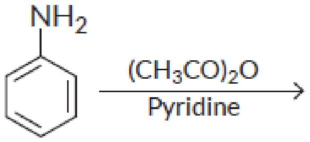
4. (i) Write an isomer of C_3H_9N which gives foul smell of isocyanide when treated with chloroform and ethanolic NaOH.
(ii) How will you convert the following :
Aniline into *N*-phenylethanamide
(Write the chemical equations involved.)
(iii) Which of the two is more basic and why?

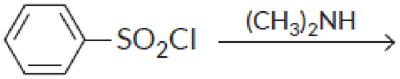


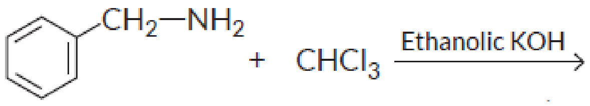
5. (a) Distinguish between the following :
   (i) $CH_3CH_2NH_2$ and $(CH_3CH_2)_2NH$
   (ii) Aniline and CH_3NH_2
   (iii) Write structures of compounds *A* and *B* in the following reaction:



6. Write the structures of the main products of the following reactions :

(i)


(ii)


(iii)


7. A compound ‘*A*’ on reduction with iron scrap and hydrochloric acid gives compound ‘*B*’ with molecular formula C_6H_7N. Compound ‘*B*’ on reaction with $CHCl_3$ and alcoholic KOH produces an obnoxious smell of carbylamine due to the formation of ‘*C*’. Identify ‘*A*’, ‘*B*’ and ‘*C*’ and write the chemical reactions involved.

8. Give reasons for the following:
(a) Reduction with iron scrap and HCl is preferred for the preparation of amines from nitro compounds.
(b) Lower aliphatic amines are soluble in water.
(c) Pyridine is used in the acylation reaction of amines.

9. Describe a method for the identification of $C_2H_5NH_2$, $(C_2H_5)_2NH$ and $(C_2H_5)_3N$. Also write the chemical equations for the reactions involved.

10. How do you convert the following :
(a) *N*-phenylethanamide to *p*-bromoaniline
(b) Benzenediazonium chloride to nitrobenzene
(c) Benzoic acid to aniline

11. An aromatic compound 'A' of molecular formula $C_7H_60_2$ on treatment with aqueous ammonia and heating forms compound 'B'. Compound B' on heating with Br and aqueous KOH gives a compound 'C' of molecular formula C_6H_7N.
Write the structures of A, B and C.`

CASE BASED QUESTIONS

1. Amines are usually formed from nitro compounds, halides, imides, etc. They exhibit hydrogen bonding which infulences their physical properties. In alkyl amines, a combination of electron releasing, steric and hydrogen bonding factors influences the stability of the substituted ammonium cations in polar solvents and thus affects the basic nature of amines. In aromatic amines, electron releasing and electron withdrawing groups, respectively increase and decrease their basic character. Influence of the number of hydrogen atoms at nitrogen atom on the type of reactions and nature of products is responsible for identification and distinction between 1^o, 2^o and 3^o amines. Presence of amino group in aromatic ring enhances reactivity of aromatic amines. Aryl diazonium salts provide advantageous methods for producing aryl halide, cyanides, phenols and arenes by reductive removal of the diazo group.

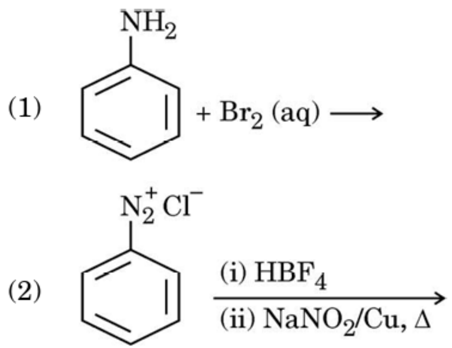
Answer the following questions:

(i) Arrange the following in the increasing order of their pKb values in aqueous solution : $C_2H_5NH_2$, $(C_2H_5)_2NH$, $(C_2H_5)_3N$ (ii) Aniline on nitration gives a substantial amount of m-nitroaniline, though amino group is no/p diecting. Why?

(iii) p-chlorobenzene diazonium chloride and p-methyl benzenediazonium chloride are taken in separate beakers. Now phenol and a few drops of NaOH is added to both the beakers. Which of the two para-substituted diazonium compounds will couple preferentially with phenol to give a coloured dye? Explain why.

OR

(iii) Complete the following reactions giving name of the product:



Hint: (

(i activating and meta-directing.

(iii) p-chlorobenzene diazonium chloride

OR

(iii) (1) 2,4,6-tribromoanoline (2) Nitrobenzene

2. Amines have a lone pair of electrons on nitrogen atom due to which they behave as Lewis base. Greater the value of K_b or smaller the value of pK_b, stronger is the base. Amines are more basic than alcohols, ethers, esters, etc. The basic character of aliphatic amines should increase with the increase of alkyl substitution. But it does not occur in regular manner as a secondary aliphatic amine is unexpectedly more basic than a tertiary amine in aqueous solutions. Aromatic amines are weaker bases than ammonia and aliphatic amines. Electron releasing groups such as $–CH_3$, $-OCH_3$, $-NH_2$, etc., increase the basicity while electron-withdrawing substituents such as $–NO_2$, -CN, halogens etc., decrease the basicity of amines.The effect of these substituents is more at para than at meta position.

(i) Which of these $(R)_4N^+Cl^-$ or $(R)_3N$ is more basic? Give reason

Or

(i) Arrange the following in the increasing order of their basic character in aqueous solution:

$(CH_3)_3N$, $(CH_3)_2NH$, NH_3, CH_3NH_2. Give reason.

(ii) Why pKb of aniline is more than that of methylamine?

(iii) Why ammonolysis of alkyl halides is not a good method to prepare pure amines? 1

3. Amines are usually formed from amides, imides, halides, nitro compounds, etc. They exhibit hydrogen bonding which influences their physical properties. In alkyl amines, a combination of electron releasing, steric and H-bonding factors influence the stability of the substituted ammonium cations in protic polar solvents and thus affect the basic nature of amines. Alkyl amines are found to be stronger bases than ammonia. Amines being basic in nature, react with acids to form salts. Aryldiazonium salts, undergo replacement of the diazonium group with a variety of nucleophiles to produce aryl halides, cyanides, phenols and arenes. Answer the following questions :

(i) How can you convert the following ?

(a) Ethanoic acid to methanamine (b) Propanenitrile to 1-aminopropane

(ii)What will be the major product when alkyl iodide is treated with large excess of ammonia?

(iii)(a) Name the reagent which can be used to convert benzene diazonium chloride into benzonitrile.

OR

(iii) (b) How will you obtain sulphanilic acid from aniline? 1

4. For a school project work teacher asked his students to dye a white hanky. Ragini and Roopali took the help of their chemistry teacher Mr. Washim Khan for the project. Ragini dyed her white hanky yellow in colour, and Roopali dyed it orange.

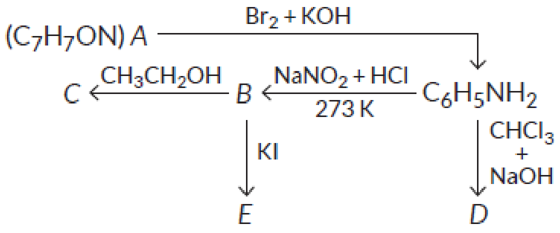
The yellow colour was formed by preparing a compound X and immediately adding aniline to it. The orange colour was formed by preparing compound X and immediately adding phenol to it.

The students saw compound X was readily soluble in cold water

a) Can an aqueous solution of compound X conduct electricity? Give a reason for your answer.
b) Write the equation showing the formation of compound X.
c) Why is aniline or phenol added immediately to compound X as soon as it is prepared?
d) Write balanced equations showing the formation of the yellow and orange dyes.

Long Answer Type Questions (5 Marks)

1. An aromatic compound '*A*' of molecular formula C_7H_7ON undergoes a series of reactions as shown below. Write the structures of *A*, *B*, *C*, *D* and *E* in the following reactions :



2. (i) How will you convert the following

(a) Benzoic acid to aniline

(b) Aniline to p-bromoaniline

(ii) Give reasons for the following:

(1) Methyl amine is more basic than aniline.

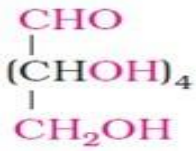
(2) Aniline readily reacts with bromine water to give 2, 4, 6-tribrornoaniline.

(3) Primary amines have higher boiling points than tertiary amines.

3. An amide 'A' with molecular formula $C_7H_7O_n$ undergoes Hoffmann bromamide degradation reaction to give amine 'B'. 'B' on treatment with nitrous acid at 273-278 K form 'C' and on treatment with chloroform and ethanolic potassium hydroxide forms 'D'. 'C' on treatment, with ethanol gives 'E.

Identify 'A', 'B', 'C', 'D' and 'E'. Write the sequence of chemical equations.

BIOMOLECULES

1	The monomeric unis of starch is / are: (a) Mannose (b) Glucose and Fructose (c) Glucose (d) Fructose
2	D – ribose and 2 – deoxy – D – ribose are (a) vitamins (b) hexose sugars (c)nucleic acids (d)pentose sugars
3	Which of the following is not present in DNA? (a) Adenine (b)Thymine (c) Uracil (d)Guanine
4	Building unit of a protein is (a) β – Aminoacid (b)λ – Aminoacid (c) γ– Aminoacid (d)α– Aminoacid
5	.________are joined together by phosphodiester linkage between 5′ and 3′ carbon atoms of the pentose sugar. (a) Nucleosides (b)Nucleic acids (c) Proteins (d)Nucleotides
6	The following molecule is called as  $CHO-(CHOH)_4-CH_2OH$ (a) Carbohydrate (b)Vitamin (c) Protein (d)Lipid
7	One or more of the following vitamin is insoluble in water (a) Vitamin D (b)vitamin K (c) Vitamin E (d)all of these
8	Night blindness is caused by the deficiency of (a) Vitamin D (b)Vitamin B (c) Vitamin C (d)Vitamin A
9	Oxime is formed by treating glucose with (a) Water (b) Nitric acid (c) Bromine water (d) Hydroxylamine
10	The monomeric unis of starch is / are: (a) Mannose (b)Glucose and Fructose (c) Glucose (d)Fructose
11	D – ribose and 2 – deoxy – D – ribose are (a) vitamins (b) hexose sugars (c) nucleic acids (d) pentose sugars
12	Which of the following is not present in DNA? (a) Adenine (b) Thymine (c)Uracil (d) Guanine
13	Building unit of a protein is (a) β – Aminoacid (b) λ – Aminoacid (c) γ– Aminoacid (d) α– Aminoacid
14	The cyclic form of fructose is called

	(a)Fructofuranose (b)Pyran (c)Furan (d)Pyranose
15	Dinucleotide is obtained by joining two nucleotides together by phosphodiester linkage. Between which carbon atoms of pentose sugars of nucleotides are these linkages present? (A) 5’ and 3’ (B) 1’ and 5’ (C) 5’ and 5’ (D) 3’ and 3’

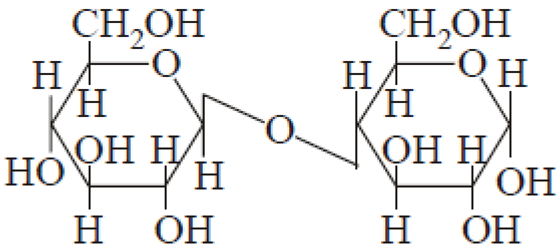
Assertion and Reason Questions

Directions: These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following four responses.
(a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
(b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
(c) If the Assertion is correct but Reason is incorrect.
(d) If both the Assertion and Reason are incorrect.

1. **Assertion :** D(+)– Glucose is dextrorotatory in nature.
   Reason : ‘D’ represents its dextrorotatory nature.

2. **Assertion :** Sucrose is called an invert sugar.
   Reason : On hydrolysis, sucrose bring the change in the sign of rotation from dextro (+) to laevo(–).

3. **Assertion :** β-glycosidic linkage is present in maltose



Reason : Maltose is composed of two glucose units in which C–1 of one glucose unit is. linked to C–4 of another glucose unit.

4. **Assertion :** At isoelectric point, the amino group does not migrate under the influence of electric field.
   Reason : At isoelectric point, amino acid exists as a zwitterion.

5. **Assertion :** Vitamin D cannot be stored in our body
   Reason : Vitamin D is fat soluble vitamin and is excreted from the body in urine

SAQ (2 MARKS)

1. How do epimers differ from anomers?
2. What type of bonding helps in stabilising the ∝ -helix structure of proteins?
3. Distinguish between α-glucose and β-glucose.
4. Define the terms as related to proteins:
   - i. Vv Peptide linkage

   ii. Primary structure
   iii. Denaturation

5. What are nucleotides? Name two classes of nitrogen containing bases found amongst nucleotides.

6. What are the common types of secondary structure of proteins?

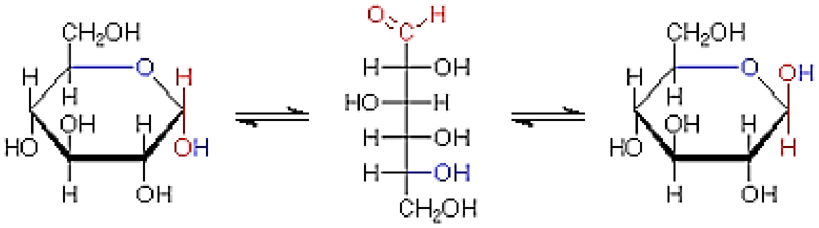
THREE MARKS QUESTIONS

1. Define the following terms:
   i. Co-enzymes
   ii. Mutation in biomolecules
   iii. List four main functions of carbohydrate in organism.
2. What happens when D-glucose is treated with the following reagents
   (A) HI
   (B) Bromine water
   (D) HNO_3
3. (a)What are the common types of secondary structure of proteins?
   (b)What are essential and non-essential amino acids? Give two examples of each type.
4. Answer the following question briefly:
   (a) What are any two food sources of vitamin A?
   (b) What are nucleotides?
   (c) How are carbohydrate classified?
5. Write down the structures and names of products formed when D-glucose is treated with:
   -Hydroxylamine
   ii- HI
   iii- Ammonical silver nitrate solution.

6. Write the important structural and functional differences between DNA and RNA
7. Give a diagrammatic representation of protein structure (two subunits of two types in quaternary structure).
8. How are harmones and vitamins different in respect of their sources and functions?
9. How do you explain the absence of aldehyde group in the pentaacetate of D-glucose?

CBQ(4 MARKS)

1. **Read the paragraph carefully and give the answers of the questions followed**.
   Glucose, Galactose, and fructose have the same chemical formula but they differ in the organization of their atoms. The sugars we have looked at so far are linear molecules (straight chains). That may seem odd because sugars are often drawn as rings. As it turns out both are correct: many five- and six-carbon sugars can exist either as a linear chain or in one or more ring-shaped forms. Cyclic sugars show mutarotation. The optical rotation of the solution depends on the optical rotation of each anomers and their ratio in the solution. Mutarotation was discovered by French chemist Augustin-Pierre Dubrunfaut in 1844, when he noticed that the specific rotation of aqueous sugar solution changes with time. These forms exist in equilibrium with each other, but equilibrium strongly favours the ring forms (particularly in aqueous, or water-based, solution). For instance, in solution, glucose's main configuration is a six-membered ring. Over 99% of glucose is typically found in this form.



(A) (B) (D)

Even when glucose is in a six-membered ring, it can occur in two different forms with different properties. During ring formation, the ‘O’ from the carbonyl, which is converted to a hydroxyl group, will be trapped either “above” the ring (on the same side as the CH_2OHCH_2OH) or “below” the ring (on the opposite side from this group).

Answer the following questions:

(a) Why D- Glucose does show mutarotation?

(b) What will be the condensation product of glucose and fructose? Which linkage is responsible for condensation of monosaccharides?

(c) Mention the difference in anomeric forms of glucose and evidence to support the cyclic forms of glucose.

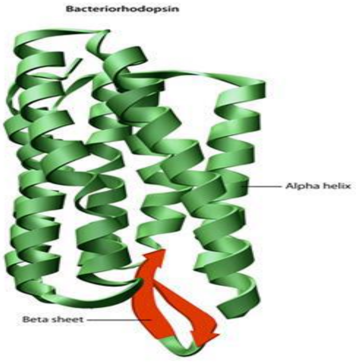
OR

(c)Under what conditions glucose is converted to gluconic and saccharic acid? Write chemical reactions.

2. **Read the paragraph carefully and give the answers of the questions followed.**

Proteins are the polymers of α -amino acids and they are connected to each other by peptide bond or peptide linkage. Chemically, peptide linkage is an amide formed between–COOH group and $–NH_2$ group. The reaction between two molecules of similar or different amino acids proceeds through the combination of the amino group of one molecule with the carboxyl group of the other. This results in the elimination of a water molecule and formation of a peptide bond –CO–NH–. The product of the reaction is called a dipeptide because it is made up of two amino acids. For example, when carboxyl group of glycine combines with the amino group of alanine we get a dipeptide, glycylalanine. Structure and shape of proteins can be studied at four different levels, i.e., primary, secondary, tertiary and quaternary, each level being more complex than the previous one.

The final shape adopted by a newly synthesized protein is typically the most energetically favourable one. As proteins fold, they test a variety of conformations before reaching their final form, which is unique and compact. Folded proteins are stabilized by thousands of noncovalent bonds between amino acids. In addition, chemical forces between a protein and its immediate environment contribute to protein shape and stability. For example, the proteins that are dissolved in the cell cytoplasm have hydrophilic (water-loving) chemical groups on their surfaces, whereas their hydrophobic (water-averse) elements tend to be tucked inside. In contrast, the proteins that are inserted into the cell membranes display some hydrophobic chemical groups on their surface, specifically in those regions where the protein surface is exposed to membrane lipids. It is important to note, however, that fully folded proteins are not frozen into shape. Rather, the atoms within these proteins remain capable of making small movements.



Answer the following questions:

(a) Name the forces responsible for secondary and tertiary structure.

(b) Where does the water present in the egg go after boiling the egg?

(c) Write one difference between α-helix and β-pleated sheet structure of protein

OR

(c) What is the difference between native protein and denatured protein?

3.Read the paragraph carefully and give answers of the questions followed.

Information regarding the sequence of nucleotides in the chain of a nucleic acid is called its primary structure. Nucleic acids have a secondary structure also. James Watson and Francis Crick gave a double strand helix structure for DNA. Two nucleic acid chains are wound about each other and held together by hydrogen bonds between pairs of bases. The two strands are complementary to each other because the hydrogen bonds are formed between specific pairs of bases. Adenine forms hydrogen bonds with thymine whereas cytosine forms hydrogen bonds with guanine. In secondary structure of RNA single stranded helix is present which sometimes folds back on itself. RNA molecules are of three types and they perform different functions. DNA is the chemical basis of heredity and may be regarded as the reserve of genetic information. DNA is exclusively responsible for maintaining the identity of different species of organisms over millions of years. A DNA molecule is capable of self-duplication during cell division and identical DNA strands are transferred to daughter cells.

Answer the following questions:

(a) Name the segment of DNA which acts as the instrumental manual for the synthesis of proteins.

(b) Name the chemical change in DNA that leads to the synthesis of proteins with different amino acids.

(c) (i) Write the sequence of chemicals present in nucleic acids.

(ii) What are the different types of RNA found in the cell?

OR

(c) Write the main functional differences between DNA and RNA. Of the four bases name those which are common to both DNA and RNA.

4. Read the paragraph carefully and give answers of the questions followed

An average Indian derives 61 to 64% of energy from consumption of food rich in carbohydrates. A study published in the journal diabetes care has recommended reducing this to 49 to 56% for remission or prevention of type-2 diabetes one of the leading causes of death worldwide. Along with reducing carbohydrates intake the study suggests that one should also increase protein intake. (14-20%) of the total energy consumption. Fats should contribute not more than 21 to 27% of the total energy consumption. In simple words 50% of plate should consist of fruits and green vegetables, 25% carbohydrates of choice, 25% contain food rich in protein. Physically inactive, obese and older individuals as well as presiding in urban locations may require greater reduction in carbohydrate intake. The keto diet, very low-calorie diet is best.

Answer the following questions:

a) Why do elderly people reduce more intake of carbohydrates than younger people?

b) Which carbohydrate are healthier out of polysaccharides, monosaccharides and disaccharides? Give reason.

c) i)Which hormone controls blood sugar in our body?

ii) Why should diabetic patients do mild exercise like walking every day?

OR

c) i) Why should protein be increased in diet especially for growing children?

ii) Why should our plate have 50% fruits and vegetables.

5.Read the paragraph carefully and give answers of the questions followed

Vitamins are vital for life. A, D, E, K are fat soluble vitamins whereas B1, B2, B3, B5, B6, B7, B9, C are water soluble vitamins. Vitamin A helps in improving eye sight. Vitamin C prevents scurvy and increases immunity. Vitamin D helps in strong bones and teeth. Our requirement of vitamin D is 15mcg. We get vitamin D from sunlight, eggs, dairy products, orange, oats and mushroom etc. Citrus fruits contain vitamin C. Carrot contains vitamin A. We should include chick pea flour in our diet to prevent inflammation. It has phytonutrients and fibres which have anti-inflammatory properties. It prevents accumulation of fats. It contains Fe, Cu, Mg, fibre, K which are essential to control our wait. It increases our immune system. It contains proteins, amino acids, Mg, vitamin B and P. Pomegranates are good source of vitamin C which our body needs to make collagen. It is rich source of B-complex, vitamin B5 folates pyridoxine and vitamin K. It contains essential minerals like Ca, Cu, Mg and Mn. Pomegranates are rich source of insoluble fibres which help us keep fuller for longer time and regulate bowel function.

Answer the following questions:

a) Why should vitamin B and C must be taken regularly in diet?
b) Which vitamin deficiency causes pernicious anemia? Is it fat or water soluble?
c) i) What is meant by vitamin B-complex?
ii) What is deficiency decease and source of vitamin E

OR

i) Which vitamin deficiency leads to bleeding for long time? What is its source?
ii) What is the role of fibre in our body?

LAQ (5MARKS)

1. Give reasons for the following observations.
   a) Amino acids behave like salts rather than simple amines or carboxylic acids.
   b) Amino acids show amphoteric behavior.
   c) The two strands of DNA are complementary to each other.
   d) Pentaacetate of glucose does not react with hydroxyl amine.
   e) Starch and cellulose both contain glucose units as monomers yet they are structurally different.
2. (a)Write the main structural difference between DNA and RNA. Of the four bases, name those which are common to both DNA and RNA.
   (b)What is the structural difference between a nucleoside and a nucleotide?
   (c) The two strands in DNA are not identical but are complementary. Explain.
3. When RNA is hydrolysed, there is no relationship among the quantities of different bases formed. What does this fact suggest about the structure of RNA?
4. (a) Which sugar is called invert sugar? Why is it called so?
   (b) How can reducing and non-reducing sugars be distinguished?
   (c)Mention the structural feature characterizing reducing sugars

CO-ORDINATION COMPOUNDS
WORKSHHET -1

Section A: Multiple Choice (1 mark each)

1. A cobalt complex was found to form a yellow solution and release Cl^- ions in $AgNO_3$ test. It had formula $[Co(NH_3)_5Cl]Cl_2$. What can be concluded?
   a) One Cl^- is ionisable
   b) All Cl^- are outside coordination sphere
   c) It is a tetrahedral complex
   d) All Cl^- are coordinated

2. A compound $[Fe(CN)_6]^{3-}$ is diamagnetic, while $[FeF_6]^{3-}$ is paramagnetic. What does this indicate about the nature of ligands?
   a) F^- causes stronger splitting
   b) CN^- is a weak field ligand
   c) CN^- causes electron pairing
   d) Both cause high spin

Section B: Assertion & Reason (1 mark each)

3. **Assertion (A):** $[Zn(NH_3)_4]^{2+}$ is colourless.
   Reason (R): Zn^{2+} has no d–d transitions.
   a) Both A and R true, R explains A
   b) Both A and R true, R doesn't explain A
   c) A true, R false
   d) A false, R true

4. **Assertion (A):** Bidentate ligands form more stable complexes than monodentate ligands.
   Reason (R): Chelate rings reduce strain and increase entropy during complexation.
   a) Both A and R true, R explains A
   b) Both A and R true, R doesn't explain A
   c) A true, R false
   d) A false, R true

Section C: Short Answer (2 marks each)

5. A complex with formula $[Cr(H_2O)_4Cl_2]Cl$ gave 1 mole of AgCl on testing with $AgNO_3$. Use this observation to write the structural formula and explain your reasoning.

   ____

   ____

   ____

6. A student observes that $[Fe(H_2O)_6]^{2+}$ shows green colour while $[Fe(en)_3]^{2+}$ shows pale purple. Justify the difference based on ligand field theory and coordination environment.

   ____

   ____

   ____

Section D: Short Answer (3 marks each)

7. A sample of $[Ni(NH_3)_6]^{2+}$ was tested and found to be paramagnetic, while $[Ni(CN)_4]^{2-}$ was diamagnetic. Predict geometry and magnetic behaviour using d^8 configuration and ligand field

strength.

8. A student compares $[Co(NH_3)_6]^{3+}$ and $[Co(en)_3]^{3+}$. One shows optical activity while the other doesn’t. Explain this observation using spatial arrangement of ligands.

Section E: Case-Based (4 marks)

1. A complex with formula $[Fe(C_2O_4)_3]^{3-}$ is used in redox titrations. It is stable, coloured, and forms a chelate with iron(III). A student wants to understand why oxalate is used.
   a)What is the oxidation state of Fe in this complex?
   b)Why is oxalate considered a bidentate ligand?
   c)Suggest why the complex is more stable than $[Fe(H_2O)_6]^{3+}$.
   d)What type of isomerism is possible in this complex?

CO- ORDINATION COMPOUND WOEKSHEET 2

Section A: Multiple Choice (1 mark each)

1. A coordination compound of Cu^{2+} reacts with glycine (H_2NCH_2COOH) to form a blue complex. If 2 moles of glycine coordinate per mole of Cu^{2+}, what is the likely coordination number of copper?
   a) 2 b) 4 c) 6 d) 8
2. A complex of cobalt has formula $[Co(NH_3)_5Cl]SO_4$. A student adds $BaCl_2$ and observes no white precipitate. What does this indicate?
   a) Sulphate is outside the coordination sphere
   b) Sulphate is coordinated to Co^{3+}
   c) No SO_4^{2-} present in the complex
   d) Cl^- is outside the coordination sphere

Section B: Assertion–Reason (1 mark each)

3. **Assertion (A):** The complex $[Co(NO_2)(NH_3)_5]^{2+}$ appears yellow, while $[Co(ONO)(NH_3)_5]^{2+}$ appears red.
   Reason (R): Both complexes are geometrical isomers.
   a) Both A and R are true and R is the correct explanation.
   b) Both A and R are true but R is not the correct explanation.
   c) A is true but R is false.
   d) A is false but R is true.
4. **Assertion (A):** $[Ni(NH_3)_6]^{2+}$ and $[Ni(en)_3]^{2+}$ have different stabilities.
   Reason (R): Chelating ligands enhance entropy and bond strength.
   a) Both A and R are true and R is the correct explanation.
   b) Both A and R are true but R is not the correct explanation.
   c) A is true but R is false.
   d) A is false but R is true.

Section C: Short Answer (2 marks each)

5. A coordination compound has the formula $[Fe(NH_3)_4(H_2O)_2]^{2+}$. Predict how many types of geometric isomers are possible. Justify using octahedral geometry.

6. In a lab synthesis, a cobalt compound reacts with oxalate ion ($C_2O_4^{2-}$) forming a violet solid. The resulting complex resists decomposition in heat and shows no $AgNO_3$ reaction. Explain two reasons for its thermal and chemical stability.

Section D: Short Answer (3 marks each)

7. The complex $[Fe(H_2O)_6]^{3+}$ is coloured, while $[Zn(H_2O)_6]^{2+}$ is colourless. Use electronic configuration to justify the observation.

8. Two complexes — $[Co(NH_3)_5Cl]SO_4$ and $[Co(NH_3)_5SO_4]Cl$ — are given to a student. Design a chemical test to distinguish between them and justify your answer.

Section E: Case-Based (4 marks)

A coordination complex with the empirical formula $K_4[Fe(C_2O_4)_3]\cdot 3H_2O$ is used in green ink formulation. The manufacturer wants to determine whether all oxalate ions are inside the coordination sphere or not. They perform both conductivity and gravimetric analysis.

a) What does the formula suggest about the number of ionisable species?

b) What role do the 3 H_2O molecules play?

c) Predict the number of free ions in solution.

d) Why is oxalate a suitable ligand for colour stability?

ALDEHYDE KETONE AND CARBOXYLIC ACID WORKSHEET-1

1. Which of the following compounds will give a ketone on oxidation with chromic anhydride (CrO_3)

(A) $(CH_3)_3CHCH_2OH$ (B) $CH_3CH_2CH_2OH$

(C) $(CH_3)_3COH$ (D) $CH_3CH_2CH_2CH_3OH$

____

2. Acetic acid reacts with PCl_5 to give :

(A) $Cl\ CH_2COCl$ (B) $ClCH_2COOH$

(C) CH_3COCl (D) CCl_3COOH

____

3. Assertion (A) : The pKa of ethanoic acid is lower than that of $ClCH_2COOH$.

Reason (R) : Chlorine shows electron withdrawing (I) effect which increases the acidic character of $ClCH_2COOH$.

____

4. Account for the following :

(1) Oxidation of aldehydes is easier as compared to ketones.

(2) The alpha hydrogen atoms of aldehydes are acidic in nature.

5. Give a simple chemical test to distinguish between ethanoic acid and ethanal.

6. Arrange the following compounds in increasing order of acidity:
Ethanoic acid, Propanoic acid, Benzoic acid

7. (i) Draw structure of the 2,4-dinitrophenylhydrazone of benzaldehyde.

(ii) Arrange the following in increasing order of their reactivity towards
HCN : CH_3COCH_3 , $(CH_3)_3C\ COCH_3$, CH_3CHO

8. Give simple chemical tests to distinguish between the following pairs of compounds :-

(1)1-phenyl propane and acetophenone

(2) Pentanal and Pentan-3-one

9. Give a chemical test and reaction to distinguish between: Aldehyde and Ketone

10. Give a reason:
i) Acetic acid exists as dimer in vapour phase.

ii) Aldehydes are more reactive than ketones towards nucleophilic addition.

WORKSHEET-2

Given below are two statements labelled as Assertion (A) and Reason (R) Select the most appropriate answer from the options given below:

Both A and R are true and R is the correct explanation of A
Both A and R are true and R is the correct explanation of A
A is true but R is false
A is false but R is true

1. Assertion: Acetaldehyde is more reactive than acetone in nucleophilic addition reactions.
   Reason: Two alkyl groups in acetone reduce the electrophilicity of the carbon.-----------------
2. Assertion : Nitration of benzoic acid gives m-nitro-benzoic acid
   Reason : Carboxyl group increases the electron density at meta-position.-------------------------
3. **Assertion** : Benzaldehyde is less reactive than ethanol towards nucleophilic attack.
   Reason : The overall effect of -I and +R effect of phenyl R group decreases the electron density on the carbon atom of / = C O group in benzaldehyde.------------------------
4. Assertion : Acetylene on treatment with alkaline KMnO4 produces acetaldehyde.
   Reason : Alkaline KMnO4 is a reducing agent.----------------------------------
5. A student was given three compounds A, B and C:
   A gave a silver mirror test.
   B reacted with iodine and NaOH to give a yellow precipitate.
   C turned blue litmus red and released CO_2 with sodium bicarbonate.

Questions:
(i) Identify A, B and C.

(ii) Write chemical equations for the tests involved.

6. Why is Carboxylic acid stronger than phenol?

Worksheets - 3 Activities

Objective: Identify and differentiate aldehydes, ketones, and carboxylic acids through reactions and observation

Instructions:

- You are given three unknown organic compounds ETHANAL labeled A, PROPANONE labeled B, and Ethanoic acid labeled as C).
- Perform **simple chemical tests** and **record observations** in the table.
- Use the results to **identify the functional group** in each compound.

Test	**Compound A**	**Compound B**	**Compound C**
Tollen’s Test			
Iodoform Test			
Sodium Bicarbonate Test			
Litmus Paper Test			

Worksheet Activity 2: Reaction Path Puzzle

Objective:

Use logical reasoning and knowledge of reaction mechanisms to complete a **reaction flowchart** involving aldehydes, ketones, and carboxylic acids.

Instructions:

Complete the missing compounds (**A to E**) and reaction conditions in the flowchart below:

Ethanol
|
Oxidizing Agent
↓
Compound A
|
Reagent: HCN
↓
Compound B
|
Reagent: Dil. NaOH, Heat
↓
Compound C
|
Reagent: $KMnO_4$ / H^+
↓
Compound D
|
Reagent: NH_3
↓
Compound E (An amide)

Questions:

1. Identify Compounds A to E with IUPAC names.

2. Write chemical equations for any three steps.

3. Which compound in this chain gives a positive iodoform test?

AMINES WORKSHEET-1

1. Anilinium hydrogen sulphate on heating at 453 – 473 K produces which of the following as a major product ?
   (A) 2-aminobenzene sulphonic acid (B) benzene sulphonic acid
   (C) 2-aminobenzoic acid (D) sulphanilic acid
2. When alkyl iodide is treated with large excess of ammonia, the major product obtained is : (A) Tertiary amine (B) Quaternary ammonium salt (C) Secondary amine (D) Primary amine
3. **Assertion (A)** : Boiling point of $(C_2H_5)_2NH$ is lower than that of n-$C_4H_9NH_2$.
   Reason (R) : Hydrogen bonding is much more extensive in $(C_2H_5)_2NH$ as compared to n-$C_4H_9NH_2$.
4. **Assertion (A)** : Aniline undergoes Friedel-Crafts reaction.
   Reason (R) : Aniline forms salt with $AlCl_3$, the Lewis acid in Friedel-Crafts reaction.
5. A compound 'X' having molecular formula C_3H_7NO, reacts with Br_2 in presence of KOH to give another Compound 'Y'. The compound Y reacts with HNO_2 to form ethanol and N_2 gas. Identify the compound X and Y and write the reactions involved.
6. How will bring out the following conversions:
   (i) Aniline to Phenol (ii) Ethanoic acid to methanamine
7. (i) Write a chemical test to distinguish between Dimethyl amine and Ethanamine
   (ii) Write the product formed when benzene diazonium chloride is treated with KI.
8. In a chemistry practical class, the teacher gave his students an amine ‘X’ having molecular formula C_2H_7N, and asked the students to identify the type of amine. One of the students, Neeta, observed that it reacts with $C_6H_5SO_2Cl$, to give a compound which dissolves in NaOH solution.
   (i) Can you help Neeta to identify the compound ‘X’ ?

   (ii) Arrange the following in the increasing order of their pKb value in aqueous phase :
   $C_6H_5NH_2$, $(CH_3)_2NH$, NH_3, CH_3NH_2, $(CH_3)_3N$

   (iii) Aniline on nitration gives considerable amount of meta product along with ortho and para products. Why ?

   (iv) Convert aniline to : (a) p-bromoaniline (b) benzene

AMINES WORKSHEET-2

1. Which of the following amines does not give foul smell of isocyanide on heating with chloroform and ethanolic KOH ?
   (A) $CH_3\ CH_2\ NH_2$ (b) $(CH_3)_2CHNH_2$ (c) $(CH_3 – CH_2)_3N$ (d)$C_6H_5\text{-}NH_2$
2. An amine ‘X’ reacts with Hinsberg reagent and the product obtained is insoluble in alkali. The amine ‘X’ is :
   (a) $(CH_3)_2 – NH$ (b) $CH_3 – CH_2 – NH_2$ (c) $(CH_3)_3N$ (d) $C_6H_5\text{-}NH$
3. Assertion (A) : Boiling point of butan-1-ol is higher than that of n-$C_4H_9NH_2$.
   Reason (R) : Being more polar, butan-1-ol forms stronger intermolecular hydrogen bonds as compared to butan-1-amine.
4. Assertion (A) : Aniline does not undergo Friedel-Crafts reaction.
   Reason (R) : Friedel-Crafts reaction is a nucleophilic substitution reaction.
5. Complete the following reactions: 2

   (i) $C_6H_5N_2^+Cl^- \frac{(i)HBF4}{(ii)NaNO2,Cu,\Delta} \rightarrow ?$

   (ii) $C_6H_5NH_2 + C_6H_5COCl \rightarrow ?$

6. How will you obtain the following from aniline ? Give chemical equations only.
   (i) p-Bromoaniline (ii) Phenylisocyanide (iii) Acetanilide

7. Give reason for the foowing: 3
   (i) N,N-Diethylbenzenesulphonamide is insoluble in alkali.
   (ii) p- nitroaniline is aweaker base than toluidine.
   (iii)Aromatic amines cannot be prepared by Gabriel Phthalimide reaction.

8. (i) Arrange the following in decreasing order of pK_b:
   aniline, p-nitroaniline, p-methylaniline

   (ii) Account for the following:
   (a) Diazonium salts of aromatic amines are more stable than those of aliphatic amines.
   (b) Methylamine in water reacts with $FeCl_3$ to precipitate hydrated ferric oxide.

Class : 12th Chemistry
Chapter-2 : Solutions (Part_2)

Solutions

Parts per million : For trace quantities

$$\frac{\text{No. of parts of components} \times 10^{6}}{\text{Total no. parts of components of solution}}$$

Normality: Number of gram equivalents of the solute dissolved in one litre of solution

$$\frac{\text{No. of gram equivalent of solute} \times 100}{\text{Volume of solution}}$$

↓

Gram Equivalents of solute

$$= \frac{\text{Mass of solute}}{\text{Equivalent weight}}$$

↓

$$\text{Equivalent weight} = \frac{\text{Molecular mass}}{\text{Valency}}$$

Mass by volume percentage (w/v)

$$\frac{\text{Mass of solute}}{\text{Volume of solution}} \times 100$$

Mass percentage w/w

$$\frac{\text{Mass of component in solution}}{\text{Total mass of solution}} \times 100$$

Volume percentage v/v

$$\frac{\text{Volume of component}}{\text{Total volume of solution}} \times 100$$

Mole fraction

$$\frac{\text{No. of moles of component}}{\text{Total No. of moles of all components}}$$

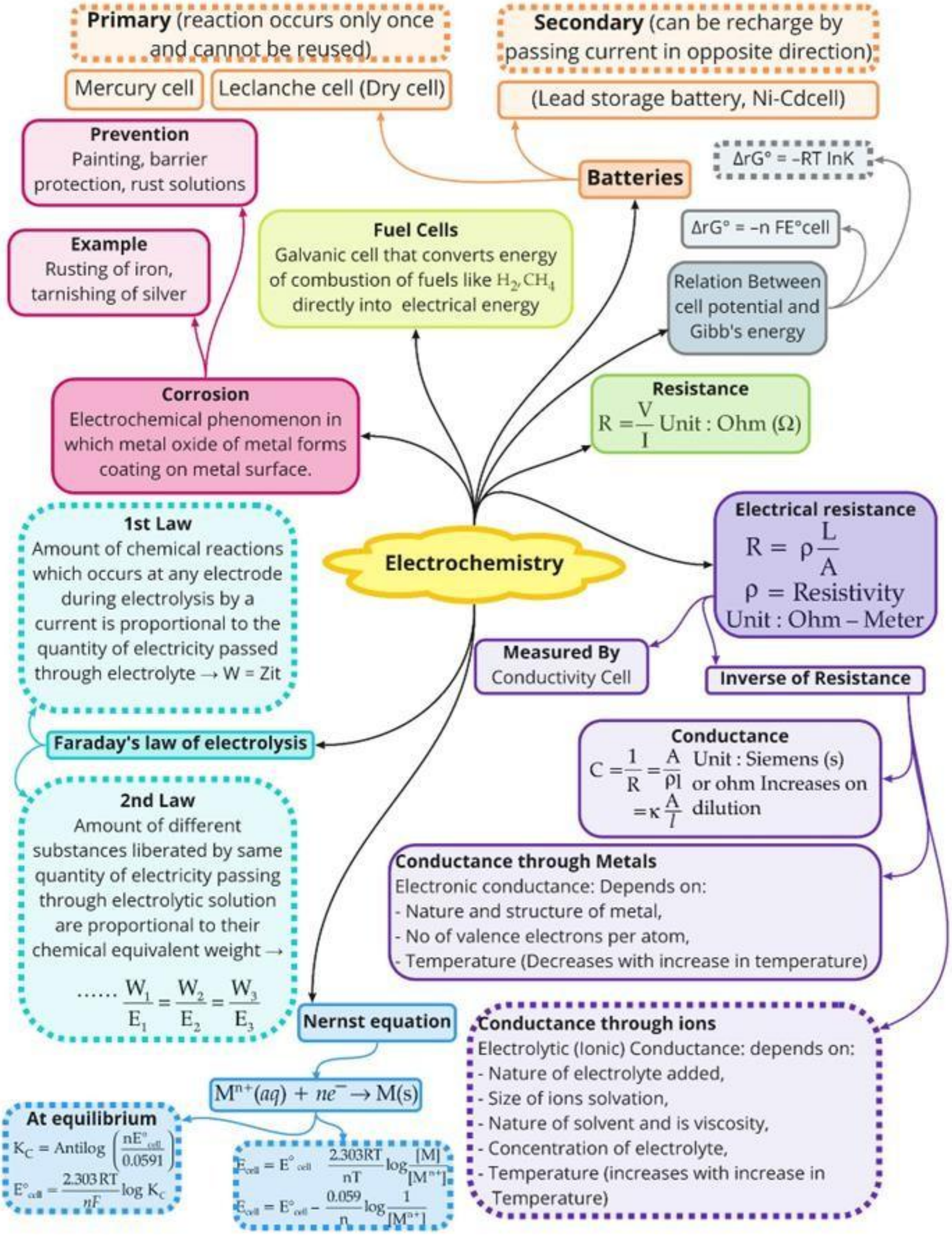
Molality: Number of moles of solute per kilogram of the solvent

$$\frac{\text{No. of moles of solute} \times 100}{\text{Mass of solvent}}$$

Molarity: Number of moles of solute in 1L solution

$$\frac{\text{No. of moles of solute} \times 100}{\text{Volume of solution}}$$

Class : 12th Chemistry
Chapter-3 : Electrochemistry (Part_1)



Electrochemistry

Batteries

Primary (reaction occurs only once and cannot be reused)
- Mercury cell
- Leclanche cell (Dry cell)

Secondary (can be recharge by passing current in opposite direction)
- (Lead storage battery, Ni-Cdcell)

Corrosion
Electrochemical phenomenon in which metal oxide of metal forms coating on metal surface.

Prevention
Painting, barrier protection, rust solutions

Example
Rusting of iron, tarnishing of silver

Fuel Cells
Galvanic cell that converts energy of combustion of fuels like H_2, CH_4 directly into electrical energy

Relation Between cell potential and Gibb's energy
- $\Delta_r G^\circ = -n FE^\circ cell$
- $\Delta_r G^\circ = -RT \ln K$

Resistance
$R = \frac{V}{I}$ Unit : Ohm (Ω)

Electrical resistance
$R = \rho \frac{L}{A}$
ρ = Resistivity
Unit : Ohm – Meter

Measured By
Conductivity Cell

Inverse of Resistance

Conductance
$C = \frac{1}{R} = \frac{A}{\rho l} = \kappa \frac{A}{l}$ Unit : Siemens (s) or ohm Increases on dilution

Conductance through Metals
Electronic conductance: Depends on:
- Nature and structure of metal,
- No of valence electrons per atom,
- Temperature (Decreases with increase in temperature)

Conductance through ions
Electrolytic (Ionic) Conductance: depends on:
- Nature of electrolyte added,
- Size of ions solvation,
- Nature of solvent and is viscosity,
- Concentration of electrolyte,
- Temperature (increases with increase in Temperature)

Faraday's law of electrolysis

1st Law
Amount of chemical reactions which occurs at any electrode during electrolysis by a current is proportional to the quantity of electricity passed through electrolyte → W = Zit

2nd Law
Amount of different substances liberated by same quantity of electricity passing through electrolytic solution are proportional to their chemical equivalent weight → ……

$$\frac{W_1}{E_1} = \frac{W_2}{E_2} = \frac{W_3}{E_3}$$

Nernst equation

$$M^{n+}(aq) + ne^{-} \rightarrow M(s)$$

$$E_{cell} = E^\circ_{cell} \frac{2.303RT}{nT} \log \frac{[M]}{[M^{n+}]}$$

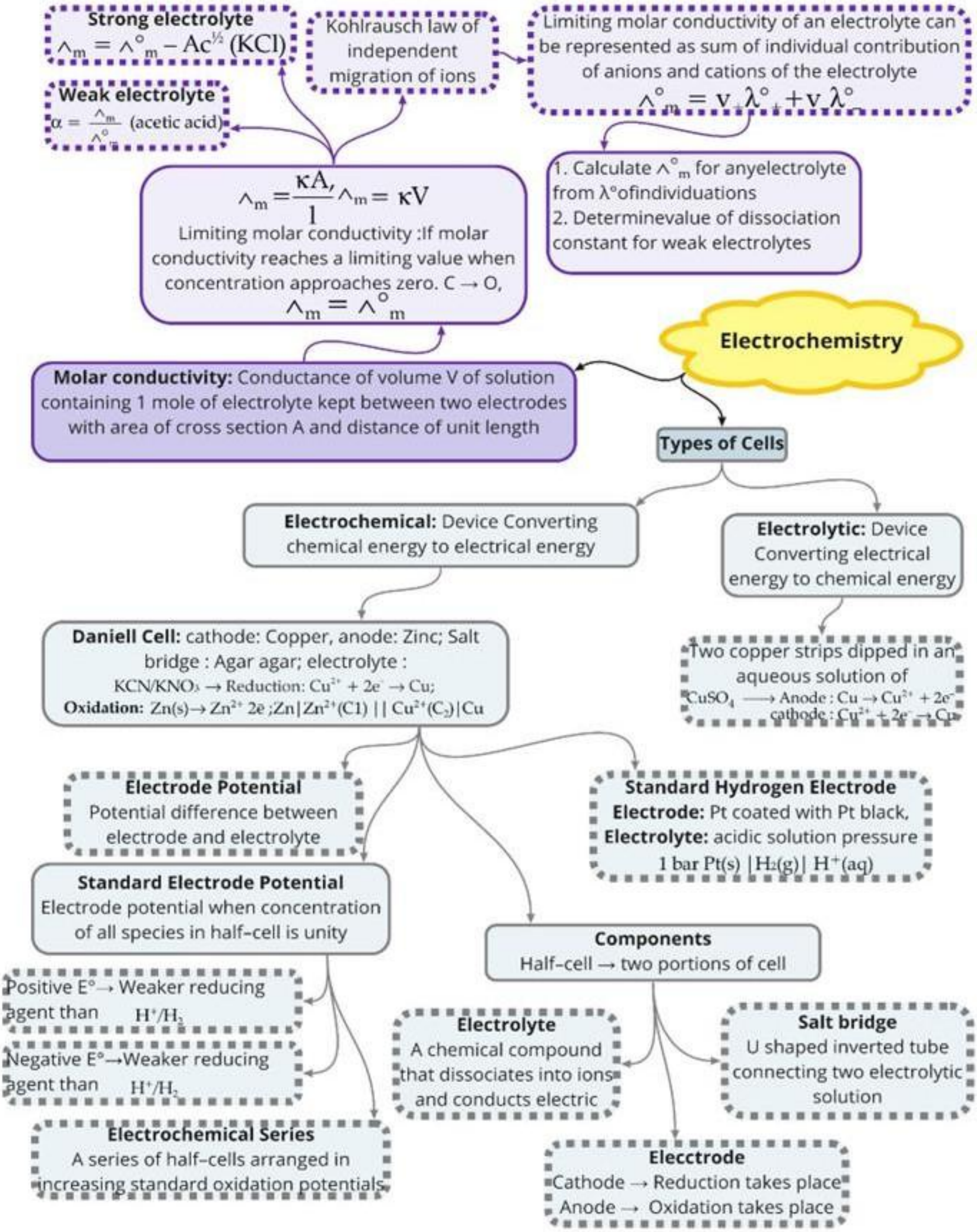
$$E_{cell} = E^\circ_{cell} - \frac{0.059}{n} \log \frac{1}{[M^{n+}]}$$

At equilibrium

$$K_C = \text{Antilog}\left(\frac{nE^\circ_{cell}}{0.0591}\right)$$

$$E^\circ_{cell} = \frac{2.303\,RT}{nF} \log K_C$$

Class : 12th Chemistry
Chapter-3 : Electrochemistry (Part_2)



Electrochemistry

Molar conductivity: Conductance of volume V of solution containing 1 mole of electrolyte kept between two electrodes with area of cross section A and distance of unit length

$\wedge_m = \frac{\kappa A,}{1} \wedge_m = \kappa V$

Limiting molar conductivity :If molar conductivity reaches a limiting value when concentration approaches zero. C → O,

$\wedge_m = \wedge^\circ_m$

Strong electrolyte

$\wedge_m = \wedge^\circ_m - Ac^{1/2}$ (KCl)

Weak electrolyte

$\alpha = \frac{\wedge_m}{\wedge^\circ_m}$ (acetic acid)

Kohlrausch law of independent migration of ions

Limiting molar conductivity of an electrolyte can be represented as sum of individual contribution of anions and cations of the electrolyte

$\wedge^\circ_m = v_+\lambda^\circ_+ + v_-\lambda^\circ_-$

1. Calculate $\wedge^\circ_m$ for anyelectrolyte from λ°ofindividuations
2. Determinevalue of dissociation constant for weak electrolytes

Types of Cells

Electrochemical: Device Converting chemical energy to electrical energy

Electrolytic: Device Converting electrical energy to chemical energy

Two copper strips dipped in an aqueous solution of

$CuSO_4 \longrightarrow$ Anode : $Cu \rightarrow Cu^{2+} + 2e^-$
cathode : $Cu^{2+} + 2e^- \rightarrow Cu$

Daniell Cell: cathode: Copper, anode: Zinc; Salt bridge : Agar agar; electrolyte :
$KCN/KNO_3 \rightarrow$ Reduction: $Cu^{2+} + 2e^- \rightarrow Cu$;
Oxidation: $Zn(s) \rightarrow Zn^{2+}\ 2e$;$Zn|Zn^{2+}(C1)||Cu^{2+}(C_2)|Cu$

Electrode Potential

Potential difference between electrode and electrolyte

Standard Electrode Potential

Electrode potential when concentration of all species in half-cell is unity

Positive E°→ Weaker reducing agent than H^+/H_2

Negative E°→Weaker reducing agent than H^+/H_2

Electrochemical Series

A series of half-cells arranged in increasing standard oxidation potentials

Standard Hydrogen Electrode

Electrode: Pt coated with Pt black,
Electrolyte: acidic solution pressure
1 bar $Pt(s)\ |H_2(g)|\ H^+(aq)$

Components

Half-cell → two portions of cell

Electrolyte

A chemical compound that dissociates into ions and conducts electric

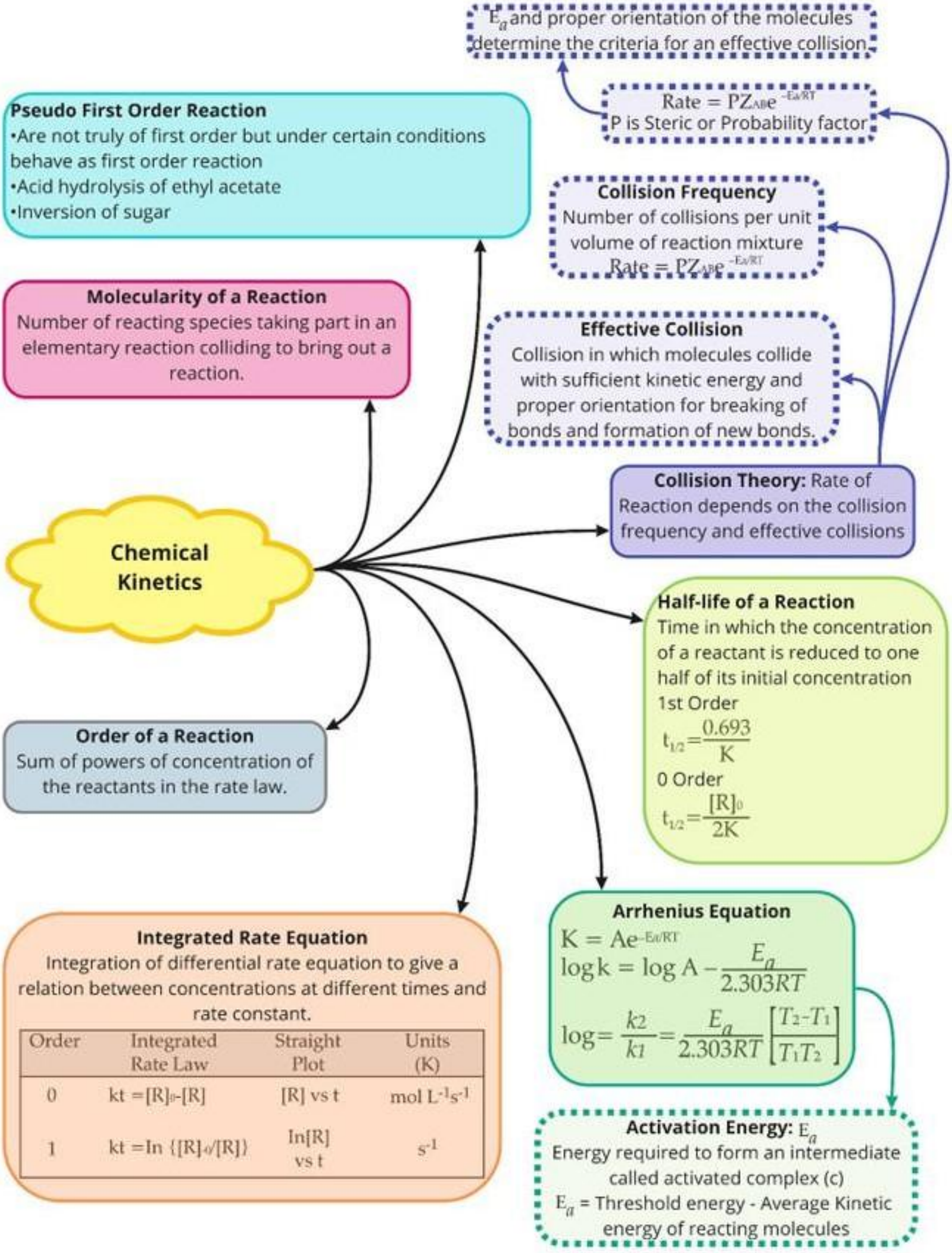
Salt bridge

U shaped inverted tube connecting two electrolytic solution

Elecctrode

Cathode → Reduction takes place
Anode → Oxidation takes place

Class : 12th Chemistry
Chapter-4 : Chemical Kinetics (Part_1)



Chemical Kinetics

Pseudo First Order Reaction
- Are not truly of first order but under certain conditions behave as first order reaction
- Acid hydrolysis of ethyl acetate
- Inversion of sugar

Molecularity of a Reaction
Number of reacting species taking part in an elementary reaction colliding to bring out a reaction.

E_a and proper orientation of the molecules determine the criteria for an effective collision.

Rate = $PZ_{AB}e^{-E_a/RT}$
P is Steric or Probability factor

Collision Frequency
Number of collisions per unit volume of reaction mixture
Rate = $PZ_{AB}e^{-E_a/RT}$

Effective Collision
Collision in which molecules collide with sufficient kinetic energy and proper orientation for breaking of bonds and formation of new bonds.

Collision Theory: Rate of Reaction depends on the collision frequency and effective collisions

Half-life of a Reaction
Time in which the concentration of a reactant is reduced to one half of its initial concentration
1st Order
$t_{1/2}=\frac{0.693}{K}$
0 Order
$t_{1/2}=\frac{[R]_0}{2K}$

Order of a Reaction
Sum of powers of concentration of the reactants in the rate law.

Integrated Rate Equation
Integration of differential rate equation to give a relation between concentrations at different times and rate constant.

Order	Integrated Rate Law	Straight Plot	Units (K)
0	$kt = [R]_0 - [R]$	[R] vs t	mol $L^{-1}s^{-1}$
1	$kt = \text{In}\{[R]_0/[R]\}$	In[R] vs t	s^{-1}

Arrhenius Equation
$K = Ae^{-E_a/RT}$
$\log k = \log A - \frac{E_a}{2.303RT}$
$\log = \frac{k2}{k1} = \frac{E_a}{2.303RT}\left[\frac{T_2-T_1}{T_1T_2}\right]$

Activation Energy: E_a
Energy required to form an intermediate called activated complex (c)
E_a = Threshold energy - Average Kinetic energy of reacting molecules

Class : 12th Chemistry
Chapter-4 : Chemical Kinetics (Part_2)

Rate of disappearance of R

$$= \frac{\text{Decease in concentration of R}}{\text{Time taken}} = \frac{-\Delta[R]}{\Delta t}$$

Rate of appearance of P

$$= \frac{\text{Increase in concentration of P}}{\text{Time taken}} = \frac{+\Delta[P]}{\Delta t}$$

$R \rightarrow P$

Average Rate

Appearance of products or disappearance of reactants over a long time interval.

$$r_{av} = \frac{d\,[P]}{dt} = \text{slope}$$

$$r_{av} = \frac{-d\,[R]}{dt} = -\text{slope}$$

Instantaneous Rate

Rate of change in concentration of reactant/product at a particular time

$$r_{inst} = \frac{-d[R]}{dt} = \frac{+d[P]}{dt}$$

Chemical Kinetics

Rate of Chemical Reaction

Change in concentration of reactants or products in unit time;

Unit : mol $L^{-1}s^{-1}$ or atm s^{-1}

Rate Law

Expression in which reaction rate in given in terms of molar concentration of reactants with each term raised to power which may or may not be same as stoichiometric coefficient of reactants in a balanced chemical equation. aA + bB - cC + dD

$$\text{Rate} = K\,[A]^{x}\,[B]^{y} = \frac{d\,[R]}{dt}$$

Rate Constant: Rate of a reaction when concentration of each of the reactant in unity

Order	Unit
0	$molL^{-1}s^{-1}$
1	s^{-1}
2	$mol^{-1}Ls^{-1}$

Factor Influencing

Concentration: Higher the concentration of reactants, faster is the rate of reaction.

Temperature: Increases with increase in temperature. becomes almost double with 10°C rise.

Presence of Catalyst: Increases with a catalyst.

Surface Area: Greater is the surface area, faster is the rate of reaction.

Activation Energy: Lower the activation energy, faster is the reaction.

Class : 12th Chemistry
Chapter-8 : The D And F Block Elements (Part_1)

The D And F Block Elements

Lanthanoid contraction in progressive decrease in atomic/ionic radii from La^{3+} and Lu^{3+}

Uses
- Helps in production of iron and steels.
- TiO in pigment industry
- MnO_2 in dry battery cells.
- As catalysts in industry.
- Ni complexes useful in the polymerization of alkynes and other organic compounds such as benzene.
- Ag Br in photographic industry.

f- Block transition elements

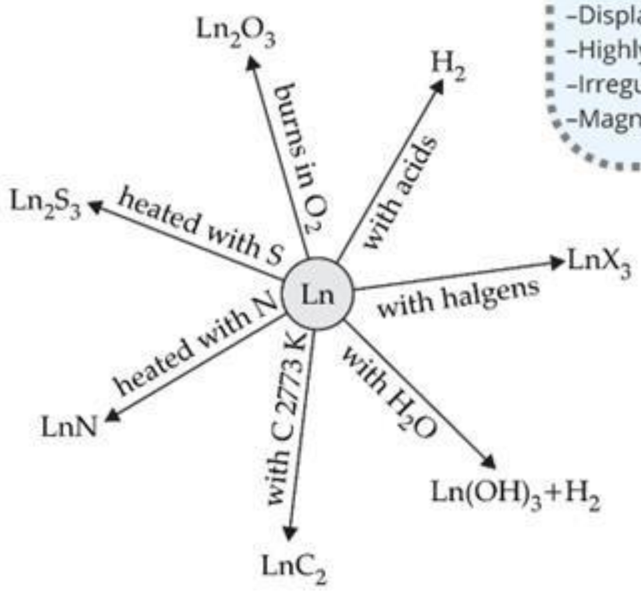
Lanthanoids

- Electronic: configuration $4f^{1-14}$ $5d^{0-1}$ $6s^2$
- Atomic and ionic sizes: Decreases from La to Lu
- Oxidation states: Most common is +3.Some elements exhibit+2 and+4.
- **General characteristics**

–Silvery while soft metals and tarnish rapidly in air.
–Hardness increases with increasing atomic number.
–Metallic structure and good conductors of heat and electricity.
–Variable density
–Trivalent Lanthanoid ions are coloured.

- **Ionisation Enthalpies:** Low third ionisation enthalpies

Chemical Properties



Actinoids

- **Electronic:** configuration $[Rn]5f^{1-14}6d^{0-2}7s^2$
- **Ionic sizes:** Gradual decrease along the series
- **Oxidation states:** Mostcommonis+3.They show ON of +4,+5, +6 and+7.
- **General characteristics:**

–Silvery in appearance
–Display variety of structures
–Highly reactive metals
–Irregularities in metallic radii, greater than in Lanthanoids.
–Magnetic properties more complex than lanthanoids.

The D And F Block Elements

d– Block transition elements groups 3–12

- **Position:** Between s–and p–blocks
- Electronic configuration: (n–1) $d^{1-10}ns^{1-2}$
- Physical properties: Show typical metallic properties, melting and boiling point are high; High enthalpies of atomization
- Decrease in radius with increasing atomic number. Lanthanoid contraction is due to imperfect shielding of one e by another in same set of orbitals.
- Ionisation enthalpies: Increases from left to right
- Oxidation states: Variable ;higher ON stable
- Trends in M^{2+}/M E°:E° for Mn,Ni and Zn are more negative than expected.
- Trends in M^{3+}/M^{2+} E°:variable
- Chemical reactivity and E° values : Variable ; Ti^{2+}, V^{2+} and Cr^{2+} are strong reducing agents.
- Magnetic properties : Diamagnetism and paramagnetism. Magnetic moment increases with increasing atomic number.
- Formation of coloured ions: Form coloured compounds due to d–d transitions
- Formation of complex compounds :Form a large number of complex compounds
- Catalytic properties : Due to variable oxidation states and ability to form complexes.
- Forms interstitial compounds :Non - stoichiometric and are neither ionic nor covalent.
- Alloy formation: Due to similar atomic sizes.

Oxides and oxoanions of metals

- Potassium dichromate $K_2Cr_2O_7$

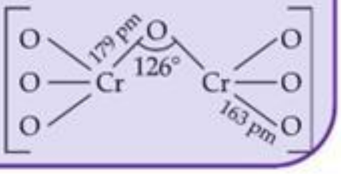
  Preparation : $4FeCr_2O_4 + 8Na_2CO_3 + 7O_2 \rightarrow 8Na_2CrO_4 + 2Fe_2O_3 + 8CO_2$

  $2Na_2CrO_4 + 2H^+ \rightarrow Na_2Cr_2O_7 + 2Na^+ + H_2O$

  $Na_2Cr_2O_7 + 2KCl \rightarrow K_2Cr_2O_7 + 2NaCl$

  Properties : $Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$

  Oxidises iodides to iodine, H_2S to S, SO_3^{2-} to SO_4^{2-}, NO_2^- to NO_3^-



- Potassium permanganate $KMnO_4$

  Preparation : $2MnO_2 + 4KOH + O_2 \rightarrow 2KMnO_4 + 2H_2O$

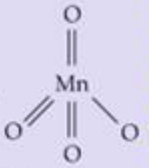
  $3MnO_4^{2-} + 4H^+ \rightarrow 2MnO_4^- + MnO_2 + 2H_2O^+$

  $2Mn^{2+} + 5S_2O_3 \quad + 8H_2O \rightarrow 2MnO_4^- + 10SO_4^{2-} + 16H^+$

  Properties : Intense colour, weak temperature dependent paramagnetism

  $MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$

  Oxidizes I^- to I_2, Fe^{2+} to Fe^{3+}, $C_2O_4^{2-}$ to CO_2, S^{2-} to S, SO_3^{2-} to SO_4^{2-}, NO_2^- to NO_3^-



Class : 12th Chemistry
Chapter-9 : Coordination Compounds (Part_1)

Coordination Compounds

Werner's Theory: Postulates

- In coordination compounds metals show primary and secondary linkages (valances)
- Primary valences are ionisable and are satisfied by negative ions.
- Secondary valences are non-ionisable and are satisfied by neutral molecules or negative ions.
- Ions/groups bound by secondary linkages to metal have characteristic spatial arrangements corresponding to different coordination numbers.

Colour

Caused by d-d transition; the colour is complementary to wavelength absorbed

Bonding

Crystal field theory

Ligands are point charges and there is electrostatic force of attraction between ligands and metal atom/ion. Degeneracy of d orbitals is lighted causing splitting of d orbitals. Δ0 depends upon the field produced by the ligand and charge on metal ion.

In metal carbonyls

Metal–carbon bond possess both σ and π character

Valance bond theory

Metal atom/ion under the influence of ligands can use its (n–1)d, ns, np or ns, np, nd orbitals for hybridisation; sp^3(Tetrahedral), dsp^2(square) planar, sp^3d (Trigonal pyramidal), sp^3d^2 and d^2sp^3 (Octahedral); Magnetic moment $= \sqrt{n(n+2)}$ BM

Uses

- In qualitative and quantitative chemical analysis.
- Estimation of hardness of water.
- In extraction metals.
- In purification of metals.
- In biological systems.
- As catalysts for industrial processes.
- In black and white photography.
- In medicinal chemistry.

Isomerism

Structural: different bonds

Ionisation counter ion is a potential ligand and can displace a ligand
$[Co(NH_3)_5SO_4]Br$
$[CO(NH_3)_5Br]SO_4$

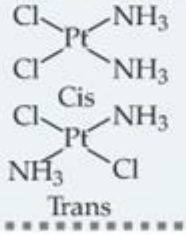
Coordination interchange of ligands between catonic and anionic entities of different metal ions
$[CO(NH_3)_6]\,[Cr(CN)_6]$
$[Cr(NH_3)_6]\,[CO(CN)_6]$

Solvate differ in number of water molecules attached to metal atom/ion
$[Cr(H_2O)_6]Cl_3$
$[Cr(H_2O)_5Cl]Cl_2.H_2O$

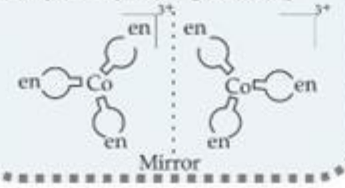
Linkage occurs in ambidentate ligand
$[CO(NO_2)(NH_3)_5]Cl$
$[CO(ONO)(NH_3)_5]Cl$

Stereoisomerism: different spatial arrangements

Geometrical: different arrangements Ligand



Optical: images which cannot be superimposed $[Co(en)_3]^{3+}$



Class : 12th Chemistry
Chapter-9 : Coordination Compounds (Part_2)

Formulas of monomuclear

- Central atom is listed first
- Ligands in alphabetical order.
- Formula is enclosed in square bracket.
- Polyatomic ligands in parenthesis.
- No space between ligand and metal.
- Charge is indicated outside brackets.
- Charge of cation(s) balanced by charge of anion(s)

Naming of monomuclear

- Cation is named first.
- Naming of ligands in alphabetical order.
- Anionic ligands end in–o, neutral and cationic are same
- Prefixes mono, di, tri etc. are used.
- Followed by roman numeral in parentheses.

Coordination Compounds

Complex compound: do not dissociate into simple ions when dissolved in water ($K_4[Fe(Cn)]_6$)

Stability: expressed by equilibrium constant

$$Br = K_1 \times K_2 \times K_3 \ldots K_n$$

Double salt: Dissociate completely into simple ions when dissolved in water.
(Mohr's salt $FeSO_4. (NH_4)2SO_4.6H_2O$)

Compounds in which a central metal atom or ion is linked to a fixed number of ions or molecules through coordinate bonds.

Terms

- Coordination entity : A central metal atom/ion bonded to fixed number of ions or molecules. $[Ni(CO)_4]$
- Central atom/ion : Atom/ion to which a fixed number of ions/groups are bound in a definite geometrical arrangement.
- Ligands : Ions or molecules bound to central atom/ion types :
  Unidentate – single donor, Didentate –two donors
  Polydentate – several donors,
  Chelating – Di-or polydentate which forms more than one coordinate bonds.
  Ambidentate : Can ligate through two different atoms.
- Coordination number : No. of ligand donor atoms to which metal is directly bonded
- Coordination sphere : Central atom/ion and the ligands attached to it and enclosed in square bracket.
- Oxidation number : Charge of central atom if all ligands are removed along with e– pairs shared with central atom.
- Homoleptic complex : Metal is bound to one type of donor groups. $[Co(NH_3)_6]_{3+}$
- Heteroleptic complex: Metal is bound to more than one type of donor groups

Class : 12th Chemistry
Chapter-10 : Haloalkanes And Haloarenes (Part_1)

Haloalkanes and Haloarenes

Racemisation S_N1

- Chiral : Objects which are non-superimposable
- Achiral : objects which are superimposable

Haloalkanes

- Preparation
  - From alcohol :

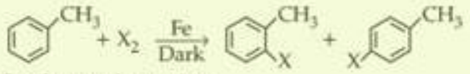
$$R{-}OH + HCl \xrightarrow{ZnCl_2} R{-}Cl + H_2O$$
$$3R{-}OH + PX_3 \longrightarrow 3R{-}X + H_3PO_3$$
$$ROH + PCl_5 \longrightarrow R{-}Cl + POCl_3 + HCl$$

  - From hydrocarbons :

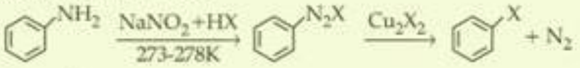
(a) By free radical halogenations

$$CH_3CH_2CH_2CH_3 \xrightarrow{Cl_2/UV} CH_3CH_2CH_2CH_2Cl + CH_3CH_2CHClCH_3$$

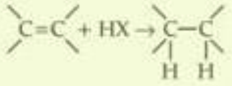
(b) By electrophilic substitution



(c) Sand meyer's reaction



(d) From alkenes



$$>C{=}C< + HX \rightarrow \underset{H}{C}{-}\underset{H}{C}$$

$$H_2C{=}CH_2 + Br_2 \xrightarrow{CCl_4} BrCH_2{-}CH_2Br$$

  - Halogen exchange :

$$R{-}X + NaI \rightarrow R - I + NaX$$

- Properties
  - Physical : Colourless, volatile, sweet smell.

Lower members are gases at room temperature while higher are solids.

B.P : RI > R Br > RCl > RF.

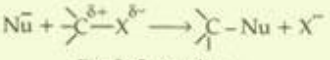
M.P : Para isomers have high m.p. than ortho and meta – isomers.

Density : Increases with increase in number of C/X atoms and atomic masses of the X atoms.

Solubility : Very slightly soluble in water.

  - Chemical :

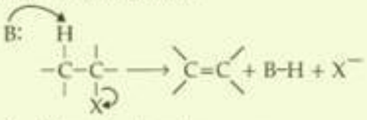
(a) Nucleophilic substitution



$$\bar{Nu} + >\overset{\delta+}{C}{-}\overset{\delta-}{X} \longrightarrow >C{-}Nu + X^-$$

$$\xrightarrow[\text{Tertiary, Secondary, Primary}]{\text{For } S_N2 \text{ reaction}}$$
$$\xleftarrow[\text{For } S_N1 \text{ reaction}]{}$$

(b) Elimination reaction



$$-\overset{H}{C}{-}\underset{X}{C}- \longrightarrow >C{=}C< + B{-}H + X^-$$

B = Base; X = Leaving group

(c) Reaction with metals

$$CH_2CH_2Br + M \longrightarrow CH_3CH_2Mg\,Br$$

Wurtz reaction :

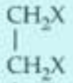
$$2RX + 2Na \xrightarrow{\text{Dry ether}} RR + 2NaX$$

Classification

- No. of halogen atoms

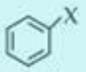
C_2H_5X

Monohaloalkane

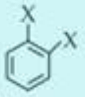


$$\begin{array}{c} CH_2X \\ | \\ CH_2X \end{array}$$

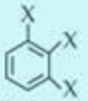
Dihaloalkane



Monohaloarene



Dihaloarene



Trihaloarene

- Compounds containing sp^3 C–X bond

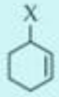
(a) Alkyl halides

$$R'{-}\underset{H}{\overset{H}{C}}{-}X$$

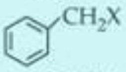
$$R''{-}\underset{H}{\overset{R'}{C}}{-}X$$

$$R''{-}\underset{R'''}{\overset{R'}{C}}{-}X$$

(b) Allylic halides



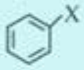
(c) Benzylic halides



- Compounds containing sp^2 C–X bond

(a) Vinylic halides

(b) Aryl halides



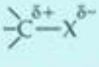
- Nomenclature

Common name : alkyl group followed by halides. Dihalogen derivatives, prefixes o–, m–, p– are used.

IUPAC name : numerals are used

- Nature of C –X bond

: Carbon –halogen bond is polarized



$$>\overset{\delta+}{C}{-}\overset{\delta-}{X}$$

Class : 12th Chemistry
Chapter-10 : Haloalkanes And Haloarenes (Part_2)

Haloalkanes and Haloarenes

Polyhalogen compounds

Carbon tetrachloride
- Manufacture of refrigerants and propellants.
- Cleaning fluid

Chloroform
- Solvent for fats, alkaloids, I etc.
- Production of Freon

Dichloromethane
- Paint remover
- Propellant in aerosols
- Metal cleaning and finishing solvent.

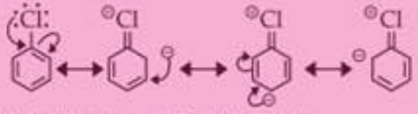
Freon's
For aerosol propellants, refrigeration and air conditioning purposes

D. DT.
As insecticide

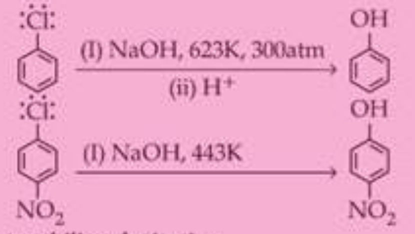
Iodoform
Antiseptic

Haloarenes

- Reactions :
  - (a) Nucleophilic substitution
    (i) Resonance effect

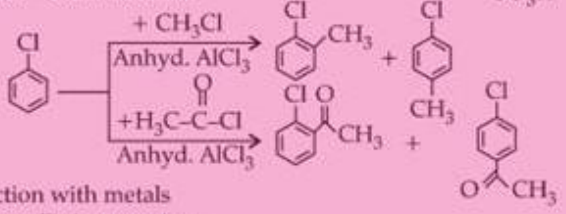


(ii) Hybridization of C – X bond in :
Haloalkane –sp^3; Haloarence –sp^2
(iii) Phenyl cation unstabilised by resonance

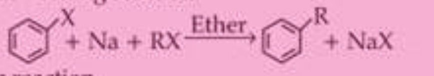


(b) Electrophilic substitution

Friedel – Crafts reaction



  - (c) Reaction with metals
    Wurtz – Fitting reaction



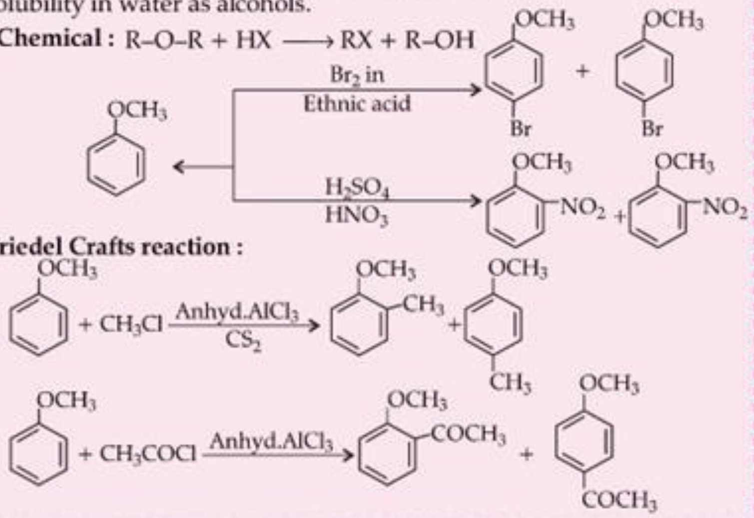
Fittig reaction

S_N2 Stereochemical inversion
(a) Dextro (+/d)
(b) laevo (–/1)

Class : 12th Chemistry
Chapter-11 : Alcohols, Phenols And Ethers (Part_1)

(i)Physical :
- C–O bonds are polar.
- Boiling points comparable to those of alkanes.
- Solubility in water as alcohols.

(ii)Chemical : $R–O–R + HX \longrightarrow RX + R–OH$



Friedel Crafts reaction :

Commercially important alcohols
- **Methanol (Wood spirit):** Used as solvent in paint, varnishes and making formaldehyde
- **Ethanol:** Used as solvent in paint industry and preparation of a number of carbon compounds.

Alcohols, Phenols And Ethers

Eather

Properties

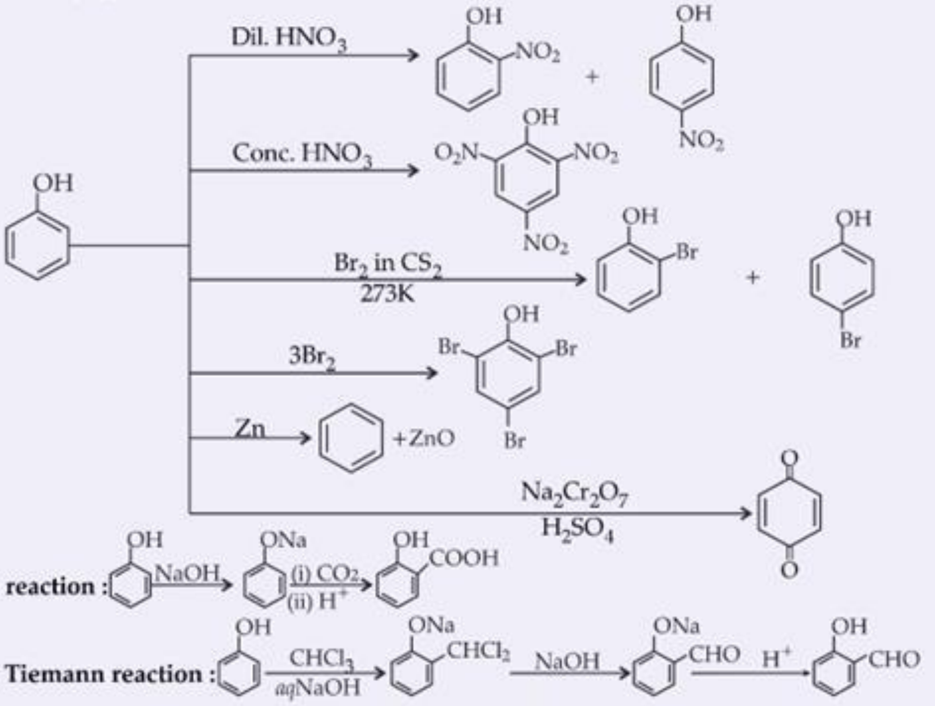
Alcohol

(i) Physical : •Boiling point increases with increase in the number of C atoms.
•Solubility decreases with increase in size of alky/aryl groups.

(ii) Chemical : $2–R–O–H + 2Na \longrightarrow 2R–O–Na + H_2$;Acidity – primary > secondary > tertiary

$Ar/RO – H + R' –COOH \xrightleftharpoons{H^+} Ar/ROCOR' + H_2O$; $ROH + HX \longrightarrow R–X + H_2O$

$C_2H_5OH \xrightarrow[443\ K]{H_2SO_4} CH_2 = CH_2 + H_2O$; $RCH_2OH \xrightarrow{Oxidations} R\text{-}\overset{H}{C}{=}O \longrightarrow R\text{-}\overset{H}{C}{=}O$



Kolbe's reaction :

Reimer Tiemann reaction :

Class : 12th Chemistry
Chapter-11 : Alcohols, Phenols And Ethers (Part_2)

Alcohols, Phenols And Ethers

Nomenclature

Ethers

Common name: alkyl/aryl groups in alphabetical order followed by ether.

IUPAC name: In alkyl /aryl group 'e' replaced by oxy followed by parent hydrocarbon.

Alcohols

Common name: Alkyl group + ol;

IUPAC name: substituting 'e' of alkane with suffix 'ol'

Phenols

Common name: Terms ortho, meta and para are used.

IUPAC name: Dihydroxy derivatives as 1,2-, 1,3-and 1,4-benzenediol

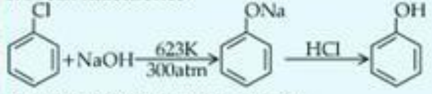
Structures of functional groups

- Oxygen of –OH group is attached to C by a σ bond formed by the overlap of sp^3 orbital of C with a sp^3 orbital of oxygen.
- In ethers, tetrahedral arrangement for four electron pairs.

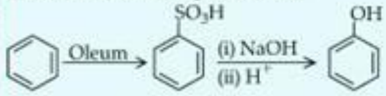
Preparation

Phenols

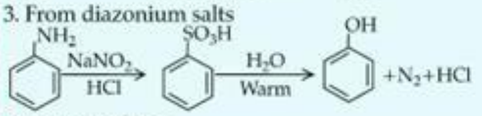
1. From haloarenes



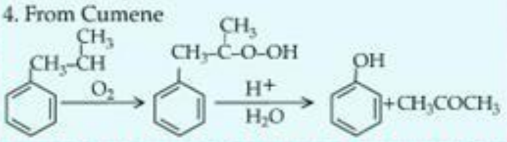
2. From benzene sulphonic acid



3. From diazonium salts

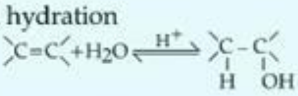


4. From Cumene



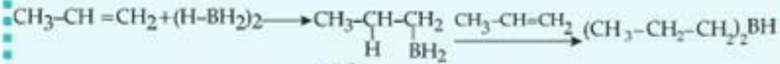
Alcohol

1. From alkenes :- (i) By acid catalysed hydration



$$>C=C<+H_2O \xrightleftharpoons{H^+} >\underset{H}{\underset{|}{C}}-\underset{OH}{\underset{|}{C}}<$$

(ii) By hydroboration – oxidation

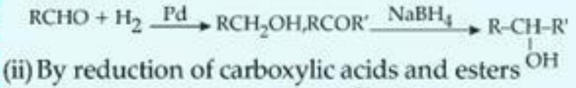


$$CH_3-CH=CH_2+(H-BH_2)_2 \longrightarrow CH_3-\underset{H}{\underset{|}{C}H}-\underset{BH_2}{\underset{|}{C}H_2} \xrightarrow{CH_3-CH=CH_2} (CH_3-CH_2-CH_2)_2BH$$

$3CH_3-CH_2-CH_2-OH+B(OH)_3 \xrightarrow[3H_2O_2,OH]{H_2O} CH_3-CH_2-CH_2)_3B ,CH_3-CH_2-CH_2$

2. From carbonyl compounds :

(i) By reduction of aldehydes and ketones

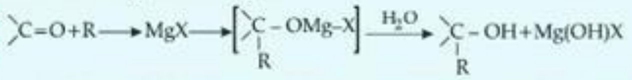


$$RCHO + H_2 \xrightarrow{Pd} RCH_2OH, RCOR' \xrightarrow{NaBH_4} R-\underset{OH}{\underset{|}{C}H}-R'$$

(ii) By reduction of carboxylic acids and esters

$$RCOOH \xrightarrow[H^+]{R'OH} RCOOR' \xrightarrow[catalyst]{H_2} RCH_2OH + R'OH$$

3. From Grignard reagent



$$>C=O+R \longrightarrow MgX \longrightarrow \left[>\underset{R}{\underset{|}{C}}-OMg-X\right] \xrightarrow{H_2O} >\underset{R}{\underset{|}{C}}-OH+Mg(OH)X$$

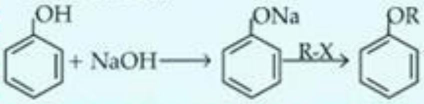
Ethers

1. By dehydration of alcohols

$$CH_3CH_2OH \xrightarrow[413\,K]{H_2SO_4} C_2H_5OC_2H_5$$

2. Williamson synthesis

$$RX + R'ONa \longrightarrow R-O-R' + NaX$$



Classification

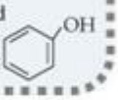
Mono, Di, Tri, or polyhydric

(i) Containing C_{sp3} – OH bond

$-CH_2OH > CHOH \geqslant COH$
(1°) (2°) (3°)

(ii) Containing C_{sp2}-OH bond

Vinylic alcohol :
$CH_2 = CH - OH$ Phenols:



Ethers

(i) Simple/symmetrical: Alkyl or aryl attached to O_2 are same.

(ii) Mixed/Unsymmetrical: Two groups are different.

Class : 12th Chemistry
Chapter-12 : Aldehydes, Ketones And Carboxylic Acids (Part_1)

Aldehydes, Ketones And Carboxylic Acids

Nomenclature

Preparation

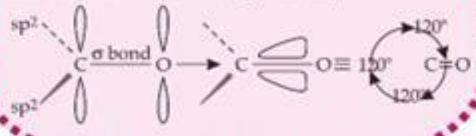
Aldehydes and Ketones

Common names :

- Replace corresponding carboxylic acids with aldehyde
- Alkyl phenyl ketones by adding acyl group as prefix to phenone.

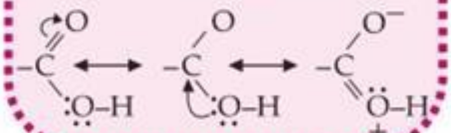
IUPAC names :

- Replacing –e with –al and –one as required.
- Structure of Carbonyl Group



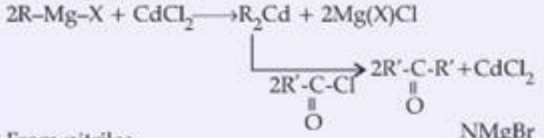
Carboxylic Acids

- Common names : end with –ic
- IUPAC names : replace –e in the corresponding alkane with –oic acid.
- Structure of Carboxyl Group



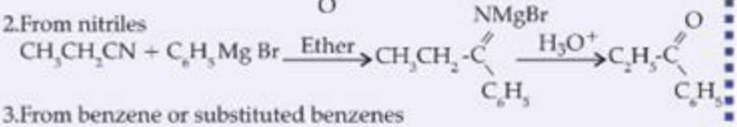
KETONES

1.From acyl chloride



$$2R\text{–}Mg\text{–}X + CdCl_2 \longrightarrow R_2Cd + 2Mg(X)Cl$$
$$R_2Cd \xrightarrow[2R'\text{-}\overset{\displaystyle O}{\overset{\|}{C}}\text{-}Cl]{} 2R'\text{-}\underset{\underset{\displaystyle O}{\|}}{C}\text{-}R' + CdCl_2$$

2.From nitriles

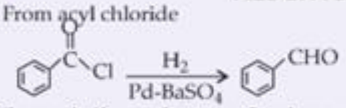


$$CH_3CH_2CN + C_6H_5MgBr \xrightarrow{Ether} CH_3CH_2\text{-}\overset{NMgBr}{\overset{\|}{C}}\text{-}C_6H_5 \xrightarrow{H_3O^+} C_2H_5\text{-}\overset{O}{\overset{\|}{C}}\text{-}C_6H_5$$

3.From benzene or substituted benzenes

ALDEHYDES

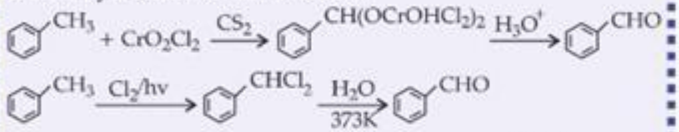
1. From acyl chloride



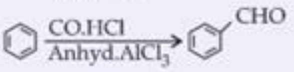
2. From nitriles and esters : Stephen reaction

$$RCN + SnCl_2 + HCl \longrightarrow RCH = NH \xrightarrow{H_3O^+} R\,CHO$$

3. From hydrocarbons : Etard reaction



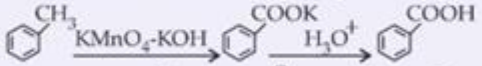
Gratterman – Koch reaction



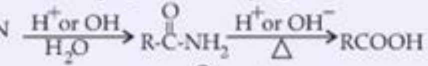
Carboxylic Acids

1.From primary alcohols and aldehydes $RCH_2OH \xrightarrow[H_3O^+]{alk.\ KMnO_4} RCOOH$

2.From alkylbenzine

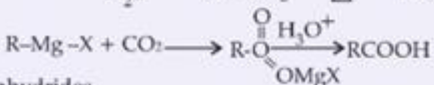


3.From nitriles and amides



$$R\text{–}CN \xrightarrow[H_2O]{H^+ or\ OH} R\text{-}\overset{O}{\overset{\|}{C}}\text{-}NH_2 \xrightarrow[\Delta]{H^+ or\ OH^-} RCOOH$$

4.From Grignard reagents



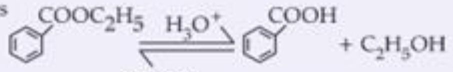
$$R\text{–}Mg\text{–}X + CO_2 \longrightarrow R\text{-}\overset{O}{\overset{\|}{C}}\text{-}OMgX \xrightarrow{H_3O^+} RCOOH$$

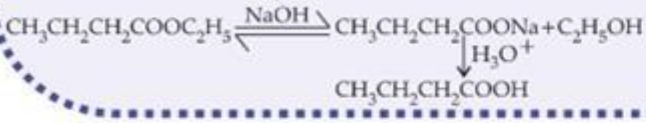
5.From acyl halides and anhydrides

$$ROCl \xrightarrow{OH^-/H_2O} RCOO^- + Cl^- \xrightarrow{H_3O^+} RCOOH$$

$$C_6H_5COOCOCH_3 \xrightarrow{H_2O} C_6H_5COOH + CH_3COOH$$

6.From esters





$$CH_3CH_2CH_2COOC_2H_5 \underset{}{\overset{NaOH}{\rightleftharpoons}} CH_3CH_2CH_2COONa + C_2H_5OH$$
$$CH_3CH_2CH_2COONa \xrightarrow{H_3O^+} CH_3CH_2CH_2COOH$$

Aldehydes, Ketones And Carboxylic Acids

Properties

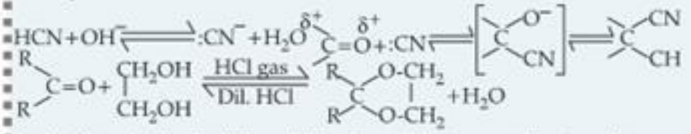
ALDEHYDES AND KETONES:

(i) Physical:

Boiling points are higher than hydrocarbons and ethers of comparable molecular masses.

(ii)Chemical :Nucleophilic addition reactions :

Aldehydes are more reactive than ketones due to steric and electronic reasons.



Reduction : (a) To alcohols – aldehydes and ketones reduce to primary and. secondary alcohols respectively by $NaBH_4$ or $LiAlH_4$.

(b) To hydrocarbons –

$$>C=O \xrightarrow[HCl]{Zn\text{-}Hg} >CH_2 + H_2O \text{ (Clemmensen Reduction)}$$

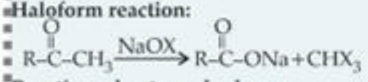
$$>C=O \xrightarrow[-H_2O]{NH_2NH_2} >C=NNH_2 \xrightarrow[Heat]{KOH/Ethylene\ glycol} >CH_2+N_2 \text{ (Wolf-Kishner)}$$

Oxidation: $RCHO \xrightarrow{[O]} R\text{–}COOH$

Tollen's test : $RCHO + 2[Ag(NH_3)]_2^+ + 3OH^- \longrightarrow RCOO^- + 2Ag + 2H_2O + 4NH_3$

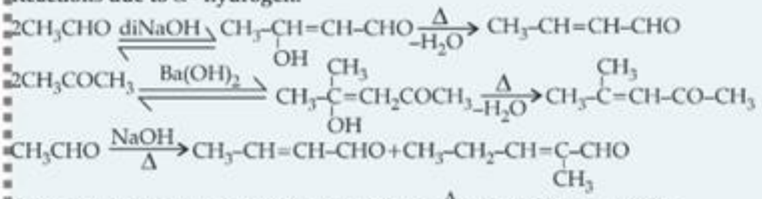
Fehling's test : $RCHO + 2Cu^{2+} + 5OH^- \longrightarrow RCOO^- + \underset{\text{Red brown ppt}}{Cu_2O} + 3H_2O$

Haloform reaction:



$$R\text{–}\overset{O}{\overset{\|}{C}}\text{–}CH_3 \xrightarrow{NaOX} R\text{–}\overset{O}{\overset{\|}{C}}\text{–}ONa+CHX_3$$

Reactions due to α - hydrogen:



$$2CH_3CHO \underset{}{\overset{diNaOH}{\rightleftharpoons}} CH_3\text{–}\underset{OH}{\underset{|}{C}H}\text{=}CH\text{–}CHO \xrightarrow[-H_2O]{\Delta} CH_3\text{–}CH\text{=}CH\text{–}CHO$$

$$2CH_3COCH_3 \overset{Ba(OH)_2}{\rightleftharpoons} CH_3\text{–}\overset{CH_3}{\overset{|}{\underset{OH}{\underset{|}{C}}}}\text{=}CH_2COCH_3 \xrightarrow[-H_2O]{\Delta} CH_3\text{–}\overset{CH_3}{\overset{|}{C}}\text{=}CH\text{–}CO\text{–}CH_3$$

$$CH_3CHO \xrightarrow[\Delta]{NaOH} CH_3\text{–}CH\text{=}CH\text{–}CHO+CH_3\text{–}CH_2\text{–}CH\text{=}\underset{CH_3}{\underset{|}{C}}\text{–}CHO$$

Cannizzaro reaction : $2HCHO + \text{conc } KOH \xrightarrow{\Delta} CH_3OH + HCOOK$

Electrophilic substitution reaction:

Carboxylic acids:

(i) Physical:

Higher boiling points than aldehydes, ketones or alcohols.

Solubility decreases with increasing number of C atoms

(ii)Chemical :

$2RCOOH + 2Na \longrightarrow 2RCOONa + H_2$

Forms corresponding anhydride on heating with mineral acid

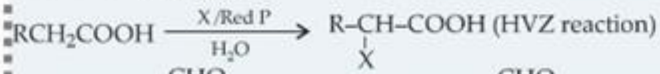
$RCOOH + R'OH \overset{H^+}{\rightleftharpoons} RCOOR' + H_2O$

$RCOOH + PCl_5 \longrightarrow RCOCl + POCl_3 + HCl$

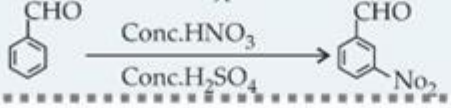
$CH_3COOH + NH_3 \rightleftharpoons CH_3COONH_4 \xrightarrow[-H_2O]{\Delta} CH_3CONH_2$

$RCOOH \xrightarrow[H_3O^+]{B_2H_6} RCH_2OH$

$RCOONa \xrightarrow[NaOH\ \&\ CaO]{Heat} R\text{–}H+Na_2CO_3$



$$RCH_2COOH \xrightarrow[H_2O]{X/Red\ P} R\text{–}\underset{X}{\underset{|}{C}H}\text{–}COOH \text{ (HVZ reaction)}$$



Uses

(a) Carboxylic acids
- Methanoic acid in rubber, textile, dyeing, leather industries.
- Ethanoic acid as solvent
- Higher tatty acids in manufacture of soaps and detergents.

(b) Aldehydes of ketones
- As solvents.
- Starting materials and reagents for synthesis ofproducts.

Class : 12th Chemistry
Chapter-13 : Amines (Part_1)

Amines

Diazonium Salts RN_2X

Diazonium Salts

Preparation :
$C_6H_5NH_2 + NaNO_2 + 2HCl \xrightarrow{273\text{-}278K} C_6H_5N_2Cl + NaCl + 2H_2O$

Physical properties : Colourless crystalline solid, soluble in water, stable in cold but reacts with water on warming.

Chemical properties :

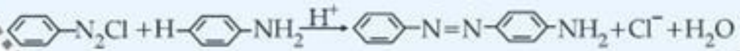
(i) Sandmeyer reaction: ArN_2X
$\xrightarrow{Cu_2Cl_2/HCl} ArCl + N_2$
$\xrightarrow{Cu_2Br_2/HBr} ArBr + N_2$
$\xrightarrow{CuCN/KCN}$

Gattermann reaction :

ArN_2X
$\xrightarrow{Cu/HCl} ArCl + N_2 + CuX$
$\xrightarrow{Cu/HBr} ArBr + N_2 + CuX$

(ii) $ArN_2Cl + KI \longrightarrow ArI + KCl + N_2$
(iii) $ArN_2Cl + HBF_4 \longrightarrow ArN_2BF_4 \xrightarrow{\Delta} ArF + BF_3 + N_2$
(iv) $ArN_2Cl + H_3PO_2 + H_2O \longrightarrow ArH + N_2 + H_3PO_3 + HCl$
(v) $ArN_2Cl + H_2O \longrightarrow ArOH + N_2 + HCl$
(iv) **Coupling reaction :**

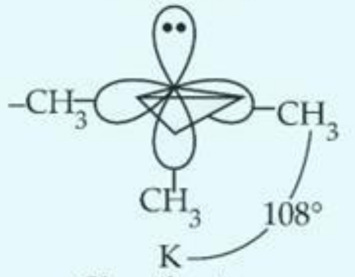
(Orange dye)



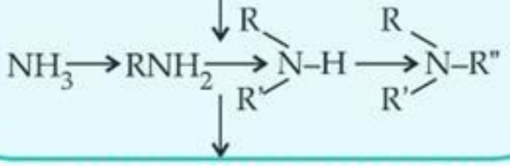
(Yellow dye)

Derivatives of ammonia, obtained by replacement of one, two or all the three Hatoms by alkyl and/or groups

Structure



Classification



$NH_3 \rightarrow RNH_2 \rightarrow R(R')N\text{–}H \rightarrow R(R')N\text{–}R''$

Nomenclature:

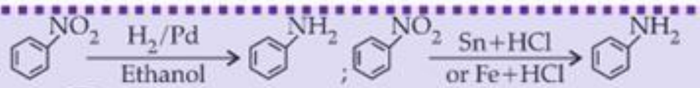
Common name: Aliphatic amine is named by prefixing alkyl group to amine. In secondary and tertiary amines prefix di or tri is put before name of alkyl group. IUPAC name : replacement of 'e' of alkane by the word amine. Suffix 'e' of arene is replaced by amine.

Physicals Properties

- Lower aliphatic amines are gases. Primary amines with three or more C atoms are liquid and higher ones are solid.
- Arylamines are colourless but get coloured on storage.
- Lower aliphatic amines are soluble in water, while higher are insoluble.
- Primary and secondary amines form intermolecular association
- Boiling point : primary > secondary > tertiary

Class : 12th Chemistry
Chapter-13 : Amines (Part_2)

1.Reduction of nitro compounds

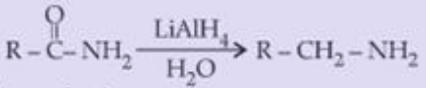


2. Ammonolysis of alkyl halides

$NH_3 + R-X \longrightarrow R-\overset{+}{N}H_3\overset{-}{X}$

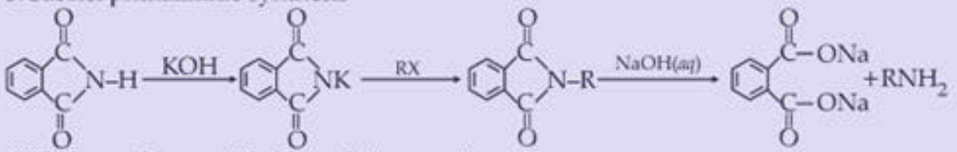
3.Reduction of nitriles $R-C\equiv N \xrightarrow[Na(Hg)/C_2H_5]{H_2/Ni} R-CH_2NH_2$

4.Reduction of amides

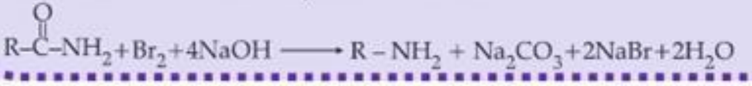


$R-\overset{O}{\overset{\|}{C}}-NH_2 \xrightarrow[H_2O]{LiAlH_4} R-CH_2-NH_2$

5.Gabriel phthalimide synthesis



6.Hoffmann bromamide degradation reaction



$R-\overset{O}{\overset{\|}{C}}-NH_2+Br_2+4NaOH \longrightarrow R-NH_2 + Na_2CO_3+2NaBr+2H_2O$

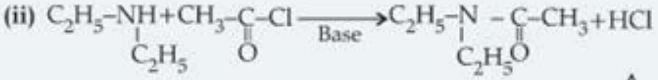
Chemical Reaction

Preparation

Amines

(i) Basic character of amines

- Reacts with acids to form salts $R-NH_2 + HX \rightleftharpoons R-NH_3X$ (salt)
- Reacts with base to regenerate parent amines
  $RNH_3X + OH \longrightarrow RNH_2 + H_2O + X$
- Order of stability of ions : 1° > 2° > 3°



(ii) $C_2H_5-\underset{C_2H_5}{\underset{|}{N}H}+CH_3-\underset{O}{\underset{\|}{C}}-Cl \xrightarrow[Base]{} C_2H_5-\underset{C_2H_5}{\underset{|}{N}}-\underset{O}{\underset{\|}{C}}-CH_3+HCl$

(iii) Carbylamines reaction : $R-NH_2 + CHCl_3 + 3KOH \xrightarrow{\Delta}$
$R-NC + 3KCl + 3H_2O$

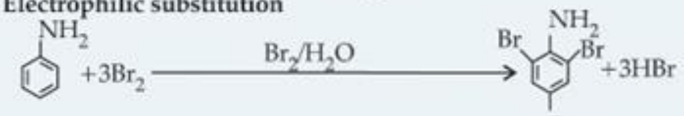
(iv) With nitrous acid

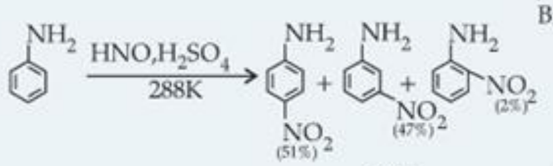
$RNH_2 + HNO_2 \xrightarrow{NaNO_2+HCl} [R-N_2Cl] \xrightarrow{H_2O} ROH + N_2 + HCl$

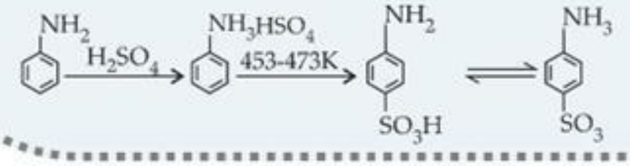
$C_6H_5NH_2 \xrightarrow[273\text{-}278K]{NaNO_2+HCl} C_6H_5N_2Cl + NaCl + 2H_2O$

(v)

(vi) Electrophilic substitution







Importance of diazonium salts in synthesis of aromatic compounds:
In preparation of substituted aromatic compounds which cannot be prepared by direct substitution in benzene/ substituted benzene.

Class : 12th Chemistry
Chapter-14 : Biomolecules (Part_1)

Nucleic Acid

Chromosomes : Particles in nucleus responsible for heredity. Chromosomes are made up of proteins and nucleic acid.
Two types : Deoxyribonucleic acid (DNA), ribonucleic acid (RNA)
Composition : In DNA, sugar is β–D–2–deoxyribose whereas in RNA is β–D–ribose. DNA contains A,G,C,T whereas RNA has A,G,C,U.
Structure : –
Nucleoside : Formed by attachment of a base to 1′ of sugar′ Nucleotide : Formed by link to phosphoric acid at 5′ of sugar.

$$-\overset{\text{Base}}{\text{Sugar}}-\text{Phosphate}-\left[\overset{\text{Base}}{\text{Sugar}}-\text{Phosphate}\right]-\overset{\text{Base}}{\text{Sugar}}-$$

Types of RNA : m–RNA, r–RNA, t–RNA
Biological Functions :

- Chemical basis of heredity.
- Responsible for identity of different species of organisms.
- Nucleic acids are responsible for protein synthesis in cell.

Biomolecules

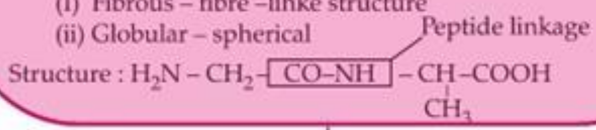
DNA Fingerprint: Unique sequence bases on DNA

Proteins

(Polymers of α–amino acids)
Amino acids contain $-NH_2$ and $-COOH$ group.

Classification:

- On the basis of relative number of $-NH_2$ and $-COOH$ group
  - (I) Neutral–equal number of $-NH_2$ and $-COOH$ group.
  - (ii) Basic – more number of $-NH_2$ than $-COOH$ group.
  - (iii) Acidic – more number of $-COOH$ than $-NH_2$ group.
- On the basis of place of synthesis
  - (i) Essential – cannot be synthesized in the body.
  - (ii) Non-essential – synthesized in the body.
- On the basis of shape
  - (I) Fibrous – fibre –linke structure
  - (ii) Globular – spherical



$$\text{Structure : }H_2N-CH_2-\overset{\text{Peptide linkage}}{\boxed{\text{CO–NH}}}-\underset{CH_3}{CH}-COOH$$

Enzymes

Globular proteins specific for particular reaction and for particular substrate. Mechanism : Reduces the magnitude of activation energy

Denaturation of proteins:

When a protein in its native form is subjected to physical change, globules unfold, helix get uncoiled and protein loses its biological activity.

Class : 12th Chemistry
Chapter-14 : Biomolecules (Part_2)

Vitamins

Organic compounds required in diet in small amounts to perform specific biological functions for maintenance and growth.

Classification:

(i) Fat soluble : Soluble in fats and oils but insoluble in water. (vitamins A,D,E and K)

(ii) Water soluble : B group and vitamin C are soluble in water.

Biomolecules

Carbohydrates

- **Classification:**

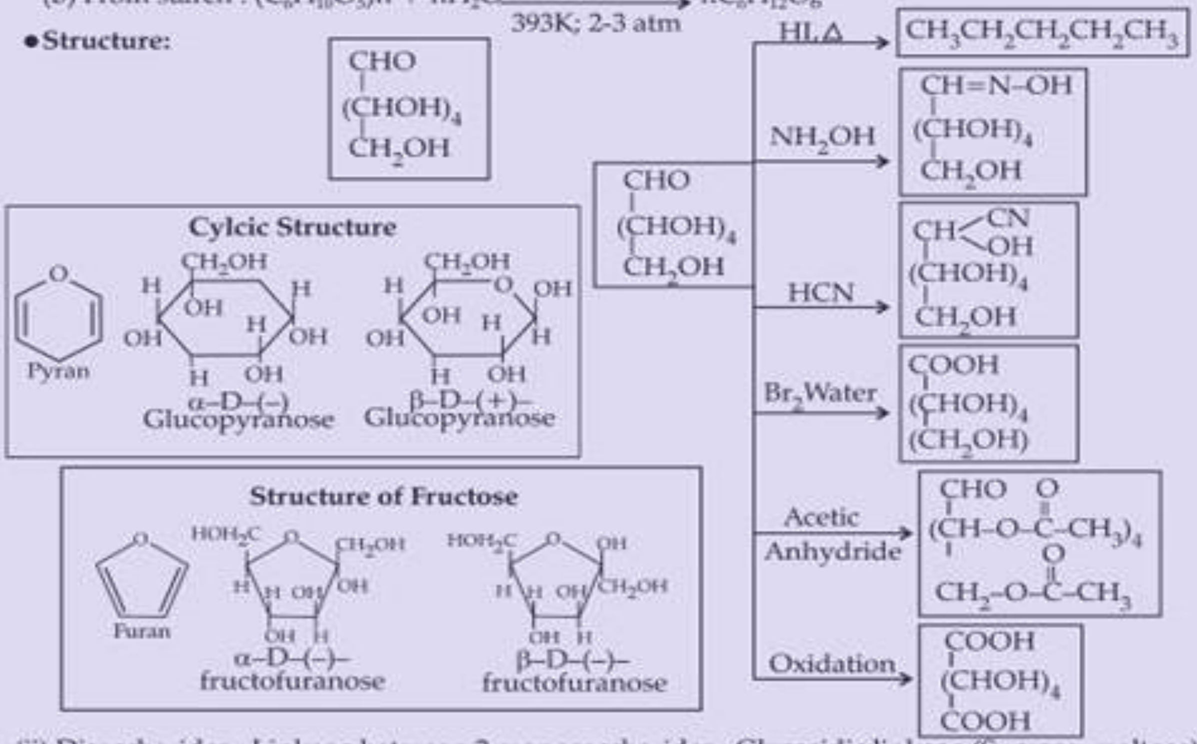
(I) Monosaccharides : (Aldehyde group – aldose, keto group –ketose)

Glucose : Preparation :

(a) From sucrose : $\underset{\text{Sucrose}}{C_{12}H_{22}O_{11}} + H_2O \xrightarrow{H^+} \underset{\text{Glucose}}{C_6H_{12}O_6} + \underset{\text{Fructose}}{C_6H_{12}O_6}$

(b) From starch : $(C_6H_{10}O_5)n + nH_2O \xrightarrow[393K;\ 2\text{-}3\ atm]{H^+} nC_6H_{12}O_6$

- **Structure:**



$\begin{array}{l} CHO \\ | \\ (CHOH)_4 \\ | \\ CH_2OH \end{array}$

$\begin{array}{l} CHO \\ | \\ (CHOH)_4 \\ | \\ CH_2OH \end{array} \xrightarrow{HI, \Delta} CH_3CH_2CH_2CH_2CH_3$

$\xrightarrow{NH_2OH} \begin{array}{l} CH{=}N{-}OH \\ | \\ (CHOH)_4 \\ | \\ CH_2OH \end{array}$

$\xrightarrow{HCN} \begin{array}{l} CH{<}^{CN}_{OH} \\ | \\ (CHOH)_4 \\ | \\ CH_2OH \end{array}$

$\xrightarrow{Br_2\,Water} \begin{array}{l} COOH \\ | \\ (CHOH)_4 \\ | \\ (CH_2OH) \end{array}$

$\xrightarrow{\text{Acetic Anhydride}} \begin{array}{l} CHO \quad O \\ | \qquad\ \ \| \\ (CH{-}O{-}C{-}CH_3)_4 \\ | \qquad\ \ O \\ \qquad\quad\ \| \\ CH_2{-}O{-}C{-}CH_3 \end{array}$

$\xrightarrow{Oxidation} \begin{array}{l} COOH \\ | \\ (CHOH)_4 \\ | \\ COOH \end{array}$

(ii) Disaccharides : Linkage between 2 monosaccharides– Glycosidic linkage (Sucrose, maltose)

(iii) Polysaccharides : Large number of monosaccharides units joined by glycosidic linkages.

(a) Starch : Polymer of α–glucose with two components amylase and amylopectin

(b) Cellulose

(c) Glycogen

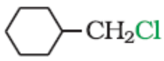
Importance:

- Form a major portion of food.
- As storage molecules.
  Cellulose forms cell wall of bacteria
- Raw materials for industries like tex

ORGANIC KA KHAJANA

Q. Which will give SN^2 faster.

1. 

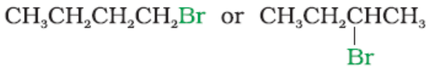
Ans. 

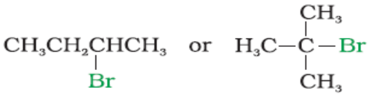
it is 1 degree halide

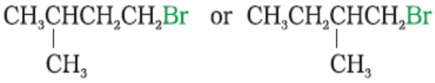
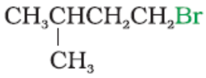
2. 

Ans. 

iodine better leaving group

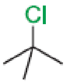
3. 
$CH_3CH_2CH_2CH_2Br$ or $CH_3CH_2\underset{Br}{C}HCH_3$
Ans. $CH_3CH_2CH_2CH_2Br$ It is 1 degree halide

4. 
$CH_3CH_2\underset{Br}{C}HCH_3$ or $H_3C-\overset{CH_3}{\underset{CH_3}{C}}-Br$
Ans. 
$CH_3CH_2\underset{Br}{C}HCH_3$
it is 2 degree halide give faster than 3 degree

5. 
$CH_3\underset{CH_3}{C}HCH_2CH_2Br$ or $CH_3CH_2\underset{CH_3}{C}HCH_2Br$
Ans. 
$CH_3\underset{CH_3}{C}HCH_2CH_2Br$
It is 1^0 with less hindered

Q. Which will give SN^1 faster.

1. 

Ans. 

It is three degree form stable carbcation

2. 

Ans. 

2^0 stable carbcation .

Practice:-. Predict the order of reactivity of the following compounds in S N^1 and SN^2 reactions:

1. $C_6H_5CH_2Br$, $C_6H_5CH(C_6H_5)Br$, $C_6H_5CH(CH_3)Br$, $C_6H_5C(CH_3)(C_6H_5)Br$
2. $CH_3CH_2CH_2CH_2Br$, $(CH_3)_2CHCH_2Br$, $CH_3CH_2CH(Br)CH_3$, $(CH_3)_3CBr$
3. 2-Bromo-2-methylbutane, 1-Bromopentane, 2-Bromopentane
4. 1-Bromo-3-methylbutane, 2-Bromo-2-methylbutane, 3-Bromo-2-methylbutane

Q. Arrange in the order of increasing reactivity toward nucleophilic addition reaction.
(i) **Methanal, Ethanal, Propanal, Propanone, Butanone**.
Ans. Butanone < Propanone <Propanal <Ethanal <Methanal
(ii) **Benzaldehyde, *p*-Tolualdehyde, *p*-Nitrobenzaldehyde, Acetophenone**. Ans. Acetophenone < *p*-Tolualdehyde < Benzaldehyde < *p*-Nitrobenzaldehyde. Ketone < electron donating group <no effect < - R nitro group iii) **Acetaldehyde, Acetone, Di-*tert*-butyl ketone, Methyl *tert*-butyl ketone** Di- tert-butylketone < Methyl *tert*-butyl ketone <Acetone < Acetaldehyde iv) **CH_3CHO ,CH_3COCH_3 ,$C_6H_5COCH_3$** Ans $C_6H_5COCH_3 < CH_3COCH_3 < CH_3CHO$

Trends in Physical properties :-

Solubility:-

1. Solubility decreases with increases in molecular mass or size of non polar hydrocarbon chain of organic compounds as it is hydrophobic.

2.Solubility increase with increase in branching as size of non polar part decreases.

1. $CH_3OH > CH_3CH_2OH > CH_3CH_2CH_2OH > C_6H_5OH$
2. $C_6H_5COOH < CH_3CH_2COOH < CH_3COOH < HCOOH$
3. $C_6H_5 –O- CH_3 < C_2H_5 -O- C_2H_5 < CH_3 –O-CH_3$
4. $C_6H_5NH_2 < CH_3CH_2CH_2NH_2 < CH_3CH_2NH_2 < CH_3NH_2$

BOILING POINT:-

1.Boiling point of organic compound increases with increase in no. of carbon atom OR molecular mass. As vanderwall force of attraction increases with increase in size.

2. Boiling point decreases with branching as surface area decreases with branching and hence force of attraction.

- **a)** Boiling point of amines:- Primary > Secondary > Tertiary
- **b)** Order of boiling point in different classes of organic compounds of nearly same molar mass.

Hydrocarbon <Haloalkanes<Ether <Aldehyde <Amines <Alcohol <Aarboxylic acid

1. $CH_3Cl < CH_3CH_2Cl < CH_3CH_2CH_2Cl < CH_3CH_2CH_2CH_2Cl$ (B.P α no. of carbon)
2. $CH_3F < CH_3Cl < CH_3Br < CH_3I$ (B.P α size)
3. $CH_3Cl < CH_2Cl_2 < CHCl_3 < CCl_4$ (B.P α molar mass)
4. $(CH_3)_3C\ Cl < CH_3CH_2CH(Cl)CH_3 < CH_3CH_3CH_2CH_2CH_2Cl$ (B.P decreases with branching)
5. $CH_3OH < CH_3CH_2OH < CH_3CH_2CH_2OH < CH_3CH_2CH_2CH_2OH$
6. $(CH_3)_3C\text{-}OH < CH_3CH_2CH(OH)CH_3 < CH_3CH_3CH_2CH_2CH_2\text{-}OH$
7. $CH_3NH_2 < CH_3CH_2NH_2 < CH_3CH_2CH_2NH_2 < CH_3CH_2CH_2CH_2NH_2$
8., $(CH_3)_3N < CH_3CH_2\ NHCH_3 < CH_3CH_2CH_2NH_2$
9. $CH_3CH_2CH_3 < CH_3CH_2Cl < CH_3 - O - CH_3 < CH_3CHO < CH_3CH_2OH < CH_3COOH$ **hydrocarbon < halide < ether < aldehyde < hydrogen bond <** form Dimer

Assignment:-

Q. arrange in order of increasing boiling point

1. Bromomethane, Bromoform, Chloromethane, Dibromomethane.

2. 1-Chloropropane, Isopropyl chloride, 1-Chlorobutane.

3 Pentan-1-ol, butan-1-ol, butan-2-ol, ethanol, propan-1-ol, methanol.

4. Pentan-1-ol, n-butane, pentanal, ethoxyethane. .

5. $CH_3CH_2CH_2CHO$, $CH_3CH_2CH_2CH_2OH$, $H_5C_2\text{-}O\text{-}C_2H_5$, $CH_3CH_2CH_2CH_2CH_3$

6. CH_3CHO, CH_3CH_2OH, CH_3OCH_3, $CH_3CH_2CH_3$

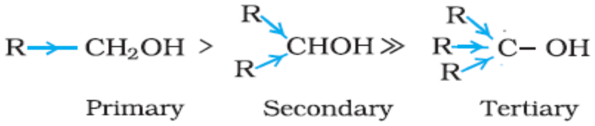
7. C_2H_5OH, $(CH_3)_2NH$, $C_2H_5NH_2$

Acidic Nature of alcohol, phenol and carboxylic acid:-

Trends in acidic nature;-

1. Alcohol < H_2O < Phenol < Carboxylic Acid

2.**In alcohol** :- with increase in NO. of +I group acidic nature decreases.



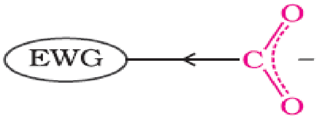
3. **In Phenol** if EWG (electron withdrawing group - NO_2, -CHO ,-CN, >C=O) attached than it stabilize phenoxide ion and increase acidic strength and EDG(electron donating group $-NH_2$,-OH ,$-OCH_3$ Alkyl) destabilize phenoxide ion and decrease acidic strength.

a) Propan-1-ol (alcohol) < 4-methylphenol (methyl is EDG) < phenol < 3-nitrophenol (nitro EWG) < 3,5-dinitrophenol (2 EWG) < 2,4, 6-trinitrophenol. (3EWG)

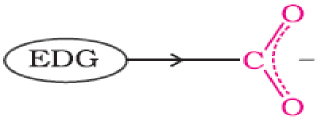
4. **Carboxylic acid :- a).** The conjugate base of carboxylic acid, a carboxylate ion, is stabilised by two equivalent resonance structures in which the negative charge is at the more electronegative oxygen atom so it is better proton donor than phenol.

b). Greater is Ka stronger is acid **or** Smaller the p*Ka*, the stronger the acid (the better it is as a proton donor). Strong acids have p*Ka* values < 1 **.**

c). Effect of substituents:-

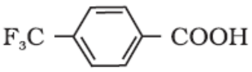
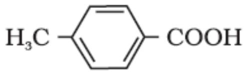
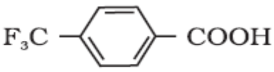


Electron withdrawing group (EWG)
stabilises the carboxylate anion
and strengthens the acid



Electron donating group (EDG)
destabilises the carboxylate
anion and weakens the acid

Arrange in order of increasing acidic strength :-

1. **HCOOH , CH_3COOH , CH_3CH_2COOH ,$ClCH_2COOH$**
   CH_3CH_2COOH **<** CH_3COOH (EDG methyl) <HCOOH < $ClCH_2COOH$ (EWG Cl)
2. **FCH_2COOH , $ClCH_2COOH$, NO_2CH_2COOH ,$BrCH_2COOH$, HCOOH** HCOOH < $BrCH_2COOH$ < $ClCH_2COOH$ < FCH_2COOH < NO_2CH_2COOH **acidic strength increases with strength of EWG**
3. **CF_3COOH , $ClCH_2COOH$, CCl_3COOH , $CHCl_2COOH$, $ClCH_2COOH$** $ClCH_2COOH$ < $CHCl_2COOH$ <CCl_3COOH < CF_3COOH
4. (acidic strength increases with increase in no. of electron withdrawing group)
5. **C_6H_5COOH , CH_3COOH** **(** CH_3COOH < C_6H_5COOH **)**
6. **CH_3COOH , CH_2FCOOH** (CH_3COOH <CH_2FCOOH)
7. **CH_2FCOOH , $CH_2ClCOOH$** ($CH_2ClCOOH$ <CH_2FCOOH)
8. **$CH_2FCH_2CH_2COOH$, CH_3CHFCH_2COOH**
   ($CH_2FCH_2CH_2COOH$, CH_3CHFCH_2COOH **)**
9.   **(**  **EWG)**

ASSIGNMENT:- arrange in increasing order of acid strength.

i)$CH_3CH_2CH(Br)COOH$, $CH_3CH(Br)CH_2COOH$, $(CH_3)_2CHCOOH$, $CH_3CH_2CH_2COOH$
(ii) Benzoic acid, 4-Nitrobenzoic acid, 3,4-Dinitrobenzoic acid, 4-Methoxybenzoic acid

BASIC NATURE OF AMINES:-

1. Amines have an unshared pair of electrons on nitrogen atom due to which they behave as **Lewis base.**
2. larger the Kb or smaller the PKb stronger is base.
3. electron donating group increase basic strength and electron withdrawing group decrease basic strength.
4. Aromatic amines (weaker base as lone pair in Resonance) < Ammonia < Aliphatic amines (stronger due to +I alkyl group)
5.**In gas Phase $3^0 > 2^0 > 1^0$ amine**
6. In aqueous solution for **methyl amines $2^0 > 1^0 > 3^0$ for ethyl amines $2^0 > 3^0 > 1^0$**
$(C2H_5)_2NH$ > $(C_2H_5)_3N$ > $C_2H_5NH_2$ > NH_3 >Aniline
$(CH_3)_2NH$ > CH_3NH_2 > $(CH_3)_3N$ > NH_3 >Aniline

Arrange in increasing order of basic strength:- **1.**
$C_6H_5NH_2$, $C_2H_5NH_2$, $(C_2H_5)_2NH$, NH_3 ($C_6H_5NH_2$ < NH_3 < $C_2H_5NH_2$< $(C_2H_5)_2NH$) . (aromatic <ammonia <aliphatic 1^0 <aliphatic2^0) 2. $C_2H_5NH_2$, $C_6H_5NH_2$, NH_3, $C_6H_5CH_2NH_2$ and $(C_2H_5)_2NH$
3 . $C_2H_5NH_2$, $(C_2H_5)_2NH$, $(C_2H_5)_3N$, $C_6H_5NH_2$
4. CH_3NH_2, $(CH_3)_2NH$, $(CH_3)_3N$, $C_6H_5NH_2$, $C_6H_5CH_2NH_2$. 5.
$C_6H_5NH_2$, $C_6H_5NHCH_3$, $C_6H_5CH_2NH_2$. 6.
$C_6H_5NH_2$, $C_6H_5N(CH_3)_2$, $(C_2H_5)_2NH$ and CH_3NH_2
Solution :- 2. $C_6H_5NH_2$ < NH_3 < $C_6H_5CH_2NH_2$ < $C_2H_5NH_2$ < $(C_2H_5)_2NH$
1. $C_6H_5NH_2$ < $C_2H_5NH_2$. < $(C_2H_5)_3N$ < $(C_2H_5)_2NH$

2. $C_6H_5NH_2 < C_6H_5CH_2NH_2 < (CH_3)_3N < CH_3NH_2 < (CH_3)_2NH$
3. $C_6H_5NH_2 < C_6H_5NHCH_3 < C_6H_5CH_2NH_2$ (aliphatic)
4. $C_6H_5NH_2 < C_6H_5N(CH_3)_2 < CH_3NH_2 < (C_2H_5)_2NH$

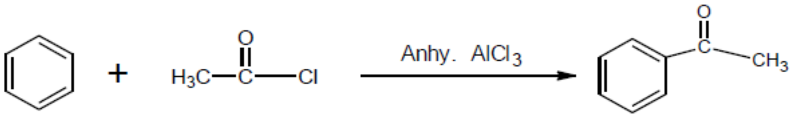
ORGANIC REAGENTS AND FUNCTION:-

REAGENT	FUNCTION	EXAMPLE
NaI /	Convert Alkyl halide to alkyl iodide	R-Cl +NaI → R-I +NaCl
AgF	Alkyl chloride to fluoride	R-Cl +AgF → R-F +AgCl
Aq. KOH/ Aq NaOH	Alkyl halide to Alcohol	R-Cl +aq. KOH → R-OH
Alc. KOH	Elimination (Alkyl halide to alkene)	CH_3CH_2Cl +alc. KOH → $CH_2=CH_2$
Na / dry ether	Alkyl halide to alkane	2RX + Na → R ---- R
$NaBH_4$	Reducing agent reduce Aldehyde to 1^0 alcohol Ketone to 2^0 alcohol	RCHO → RCH_2OH
$LiAlH_4$	Reducing agent Reduce acid to alcohol	RCOOH → RCH_2OH
Conc. H_2SO_4 at 443k	Convert alcohol to alkene	CH_3CH_2OH → $CH_2=CH_2$
Conc. H_2SO_4 at 413k	Convert alcohol to ether	$2CH_3CH_2OH$ → $CH_3CH_2OCH_2CH_3$
Anhy. CrO_3	Oxidize alcohol to aldehyde	RCH2OH → RCHO
pyridinium chlorochromate (PCC)	Convert alcohol to aldehyde Not affecting double bond	RCH=CH – CH_2- CH_2-OH → RCH=CH – CH_2- CHO
Cu / 573 K	Convert 1^0 alcohol to aldehyde Convert 2^0 alcohol to ketone 3^0 to alkene	
$KMnO_4$ / H+ **OR** $K_2Cr_2O_7$ /H+	Primary alcohol to carboxylic acid	CH_3CH_2OH → CH_3COOH
Pd +$BaSO_4$	Rosenmund	RCOCl → RCHO
$SnCl_2$ + HCl **OR** DIBAL -H	Convert nitrile to adehyde. DIBAL- H not affect the double bond	R –CH2- **CN** → R-CH_2-**CHO**
$[Ag(NH_3)_2]^+$ Tollens reagent	Oxidize aldehyde to acid (siler mirror form)	R-**CHO** → **RCOOH + Ag**
Fehling reagent	A . Aq copper sulphate B Na, K tartrate	RCHO → RCOO- + Cu_2O
NaOH + I_2	Methyl ketone to acid having one carbon less and it does not affect double bond	R-CO- **CH_3** → R-CO-**ONa + CHI_3**
$SOCl_2$, PCl_5, PCl_3	Chlorinating agent Alcohol to alkyl halide Acid to alkanoyl halide	CH_3CH_2OH → CH_3CH_2Cl CH_3COOH → CH_3COCl

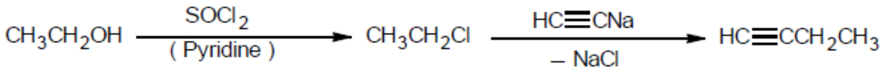
CrO_2Cl_2 + H_3O^+	Converts toluene to benzaidehyde	Etard reaction
O_3/H_2O-Zn dust	Alkene to carbonyl	$CH_3\text{-}CH_2\text{=}CH_2 \longrightarrow CH_3CHO + HCHO$
Red P_4 + X_2	Acid to alpha halo acid	R-**CH_2**-COOH $\longrightarrow$ R-**CH(X)** –COOH
KMn0$_4$ +KOH	Alkyl bezene to benzoic acid	
$NH_2\text{-}NH_2$ + KOH in ethylene glycol	Reduce Aldehyde /ketone to hydrocarbon	$CH_3CHO \longrightarrow CH_3\text{- }CH_3$ (Wolf- kishner)
Zn-Hg + Conc HCl	Reduce Aldehyde /ketone to hydrocarbon	$CH_3CHO \longrightarrow CH_3\text{- }CH_3$ (clemensen)
NaOH + CaO + Heat	Decarboxylation convert sodium salt of acid to alkane havin one carbon less	R-CH_2-**COONa** $\longrightarrow$ R –CH_2- **H** + Na_2CO_3
HNO_2 at 0-5^{0}C		R-CH_2-**NH_2** $\longrightarrow$ R-CH_2-**OH** **(Alipahatic amines) --- alcohol**
HNO_2 at 0-5^{0}C		C6H5-**NH2** (Aniline) $\longrightarrow$ C6H5-**N=N-Cl**

CONVERSIONS:-

Benzene into Acetophenone

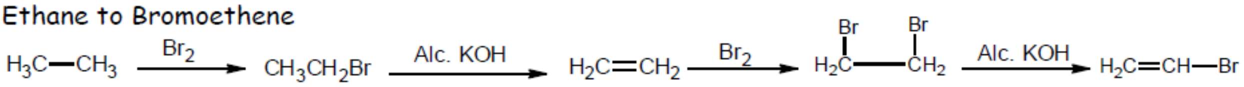


Ethanol into but-1-yne



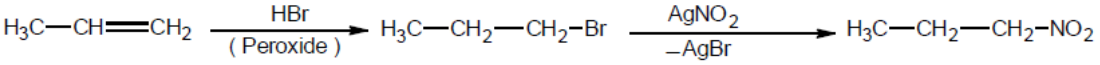
$$CH_3CH_2OH \xrightarrow[\text{(Pyridine)}]{SOCl_2} CH_3CH_2Cl \xrightarrow[-\text{ NaCl}]{HC\equiv CNa} HC\equiv CCH_2CH_3$$

Ethane to Bromoethene



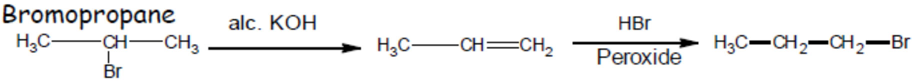
$$H_3C\text{—}CH_3 \xrightarrow{Br_2} CH_3CH_2Br \xrightarrow{\text{Alc. KOH}} H_2C\text{=}CH_2 \xrightarrow{Br_2} H_2\underset{}{\overset{Br}{C}}\text{—}\overset{Br}{C}H_2 \xrightarrow{\text{Alc. KOH}} H_2C\text{=}CH\text{—}Br$$

Propene into 1-nitropropane



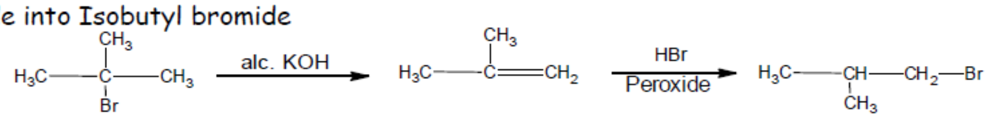
$$H_3C\text{—}CH\text{=}CH_2 \xrightarrow[\text{(Peroxide)}]{HBr} H_3C\text{—}CH_2\text{—}CH_2\text{—}Br \xrightarrow[-AgBr]{AgNO_2} H_3C\text{—}CH_2\text{—}CH_2\text{—}NO_2$$

2- Bromopropane into 1-Bromopropane



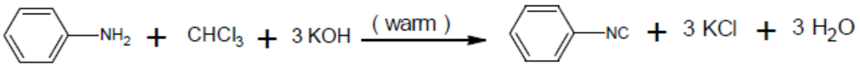
$$H_3C\text{—}\underset{Br}{CH}\text{—}CH_3 \xrightarrow{\text{alc. KOH}} H_3C\text{—}CH\text{=}CH_2 \xrightarrow[\text{Peroxide}]{HBr} H_3C\text{—}CH_2\text{—}CH_2\text{—}Br$$

tert.butyl bromide into Isobutyl bromide

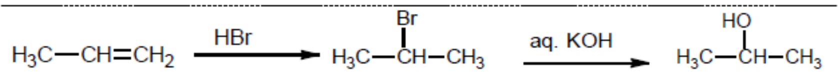


$$H_3C\text{—}\overset{CH_3}{\underset{Br}{C}}\text{—}CH_3 \xrightarrow{\text{alc. KOH}} H_3C\text{—}\overset{CH_3}{C}\text{=}CH_2 \xrightarrow[\text{Peroxide}]{HBr} H_3C\text{—}\underset{CH_3}{CH}\text{—}CH_2\text{—}Br$$

Aniline into Phenylisocyanide

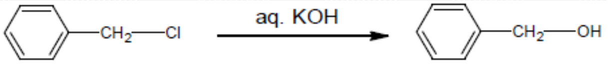


Propene into Propan-2-ol

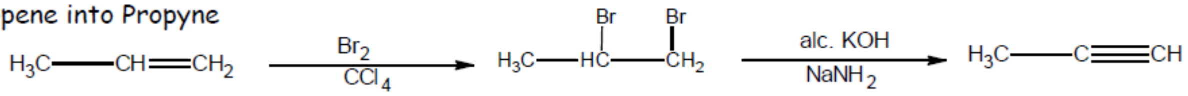


$$H_3C\text{—}CH\text{=}CH_2 \xrightarrow{HBr} H_3C\text{—}\overset{Br}{C}H\text{—}CH_3 \xrightarrow{\text{aq. KOH}} H_3C\text{—}\overset{HO}{C}H\text{—}CH_3$$

Benzyl chloride into Benzyl alcohol



Propene into Propyne

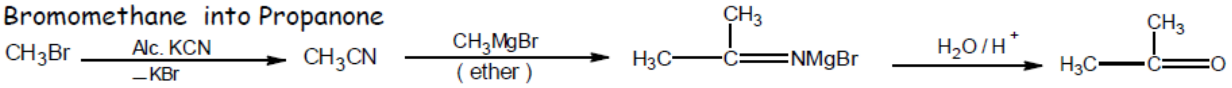


$$H_3C-CH=CH_2 \xrightarrow[CCl_4]{Br_2} H_3C-\overset{Br}{HC}-\overset{Br}{CH_2} \xrightarrow[NaNH_2]{alc.\ KOH} H_3C-C\equiv CH$$

Ethanol into Fluoroethane

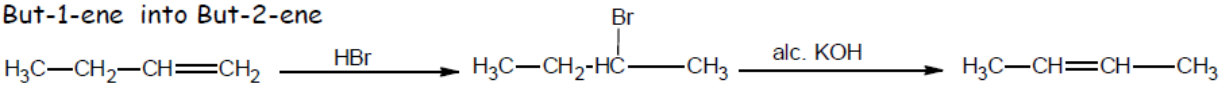
$$H_3C-CH_2-OH \xrightarrow[(Pyridine)]{SOCl_2} H_3C-CH_2-Cl \xrightarrow[-Hg_2Cl_2]{Hg_2F_2} H_3C-CH_2-F$$

Bromomethane into Propanone



$$CH_3Br \xrightarrow[-KBr]{Alc.\ KCN} CH_3CN \xrightarrow[(ether)]{CH_3MgBr} H_3C-\overset{CH_3}{C}=NMgBr \xrightarrow{H_2O/H^+} H_3C-\overset{CH_3}{C}=O$$

But-1-ene into But-2-ene

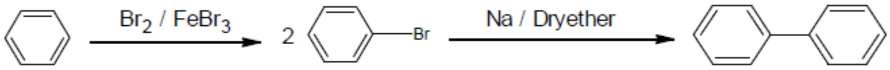


$$H_3C-CH_2-CH=CH_2 \xrightarrow{HBr} H_3C-CH_2-\overset{Br}{HC}-CH_3 \xrightarrow{alc.\ KOH} H_3C-CH=CH-CH_3$$

1- Chlorobutane into n- Octane

$$H_3C-CH_2-CH_2-CH_2-Cl + 2\ Na \xrightarrow[(Wurtz\ reaction)]{Dry\ ether} H_3C-(CH_2)_6-CH$$

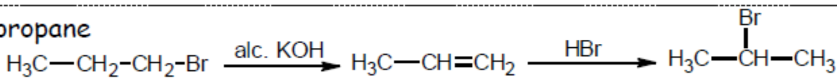
Benzene into Biphenyl



Propene into Propan-1-ol

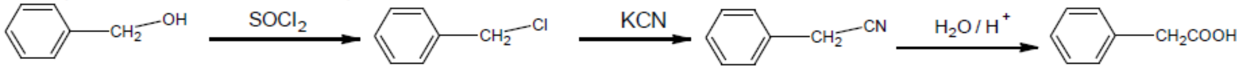
$$H_3C-CH=CH_2 \xrightarrow[Peroxide]{HBr} H_3C-CH_2-CH_2-Br \xrightarrow{Aq.\ KOH} H_3C-CH_2-CH_2-OH$$

1- Bromopropane into 2-Bromopropane



$$H_3C-CH_2-CH_2-Br \xrightarrow{alc.\ KOH} H_3C-CH=CH_2 \xrightarrow{HBr} H_3C-\overset{Br}{CH}-CH_3$$

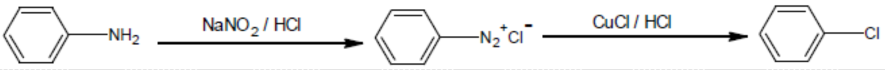
Benzyl alcohol into 2-Phenylethanoic acid



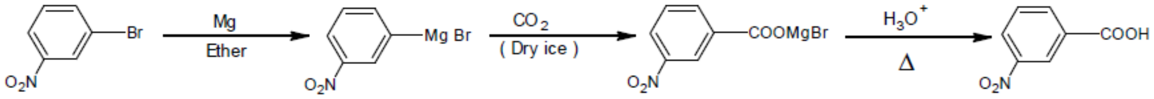
Ethanol into Propanenitrile

$$H_3C-CH_2-OH \xrightarrow[(Pyridine)]{SOCl_2} H_3C-CH_2-Cl \xrightarrow{KCN} H_3C-CH_2-CN$$

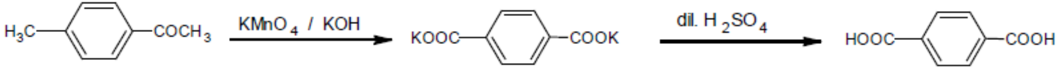
Aniline into Chlorobenzene



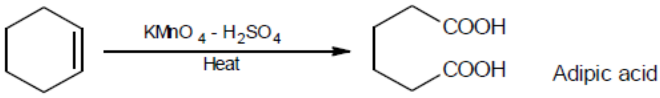
3-Nitrobromobenzene into 3-Nitrobenzoic acid



4-Methylacetophenone into Benzene-1,4-dicarboxylic acid



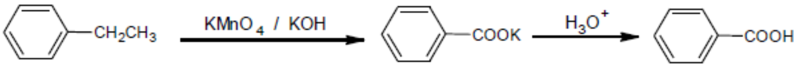
Cyclohexene into Hexane-1,6-dioic acid



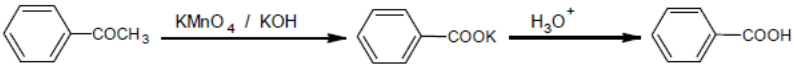
Butanal into Butanoic acid

$$H_3C-CH_2-CH_2-CHO \xrightarrow{Tollen's\ reagent} H_3C-CH_2-CH_2-COOH$$

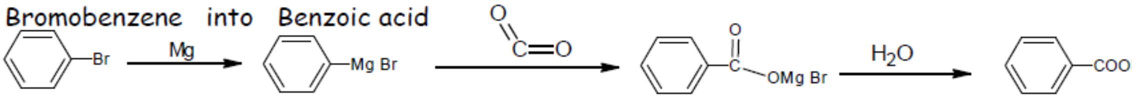
Ethylbenzene into Benzoic acid



Acetophenone into Benzoic acid



Bromobenzene into Benzoic acid



Hexanenitrile into 1-aminopentane

$$H_3C-(CH_2)_4-C\equiv N \xrightarrow[H_2O_2]{H_2O\ /\ HO^-} H_3C-(CH_2)_4-CONH_2 \xrightarrow{Br_2\ +\ 4\ KOH} H_3C-(CH_2)_3-CH_2-NH_2$$

Methanol into ethanoic acid

$$H_3C-OH \xrightarrow{SOCl_2} H_3C-Cl \xrightarrow{KCN} H_3C-CN \xrightarrow{H_2O\ /\ H^+} CH_3COOH$$

Etahnamine into methanamine

$$CH_3CH_2NH_2 \xrightarrow[(HNO_2)]{NaNO_2\ +\ HCl} CH_3CH_2OH \xrightarrow[OH^-]{KMnO_4} CH_3COOH \xrightarrow[\Delta]{NH_3} CH_3CONH_2 \xrightarrow{Br_2\ +\ 4\ KOH} CH_3NH_2$$

Methanamine into ethanamine

$$CH_3NH_2 \xrightarrow[(HNO_2)]{NaNO_2\ +\ HCl} H_3C-OH \xrightarrow{SOCl_2} H_3C-Cl \xrightarrow{KCN} H_3C-CN \xrightarrow{LiAlH_4} CH_3CH_2NH_2$$

Ethanoic acid into Propanoic acid

$$CH_3COOH \xrightarrow{B_2H_6\ /\ H_3O^+} CH_3CH_2OH \xrightarrow{SOCl_2} CH_3CH_2Cl \xrightarrow{KCN} CH_3CH_2CN \xrightarrow{H_2O\ /\ H^+} CH_3CH_2COOH$$

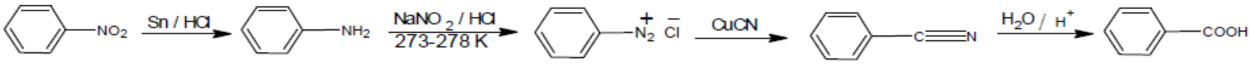
Propanoic acid into ethanoic acid

$$CH_3CH_2COOH \xrightarrow[\Delta]{NH_3} CH_3CH_2CONH_2 \xrightarrow{Br_2\ +\ 4\ KOH} CH_3CH_2NH_2 \xrightarrow[(HNO_2)]{NaNO_2\ +\ HCl} CH_3CH_2OH \xrightarrow[OH^-]{KMnO_4} CH_3COOH$$

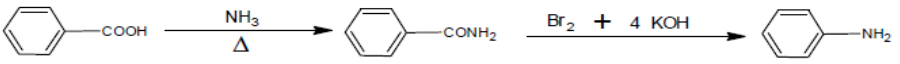
Ethanoic acid into methanamine

$$CH_3COOH \xrightarrow[\Delta]{NH_3} CH_3CONH_2 \xrightarrow{Br_2\ +\ 4\ KOH} CH_3NH_2 + K_2CO_3 + 2\ KBr + 2\ H_2O$$

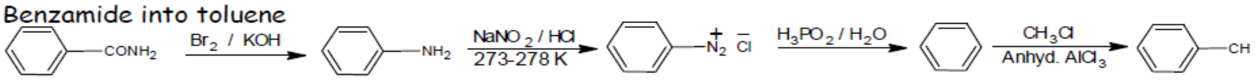
Nitrobenzene into benzoic acid



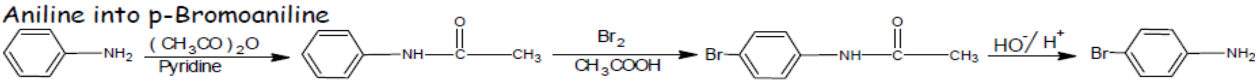
Benzoic acid into aniline



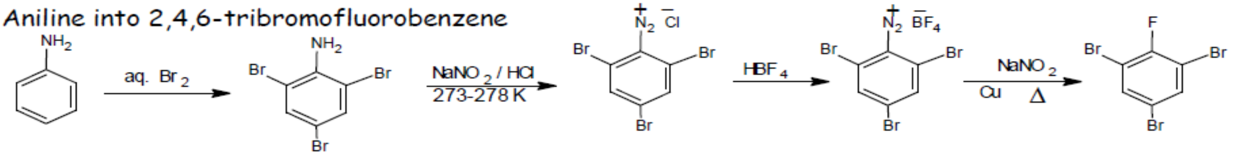
Benzamide into toluene



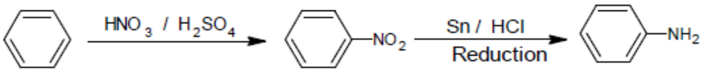
Aniline into p-Bromoaniline



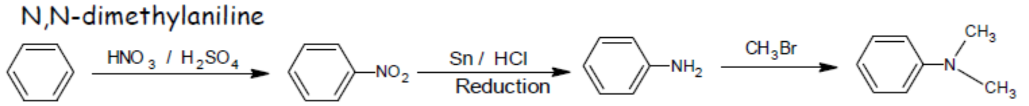
Aniline into 2,4,6-tribromofluorobenzene



Benzene into Aniline



Benzene into N,N-dimethylaniline



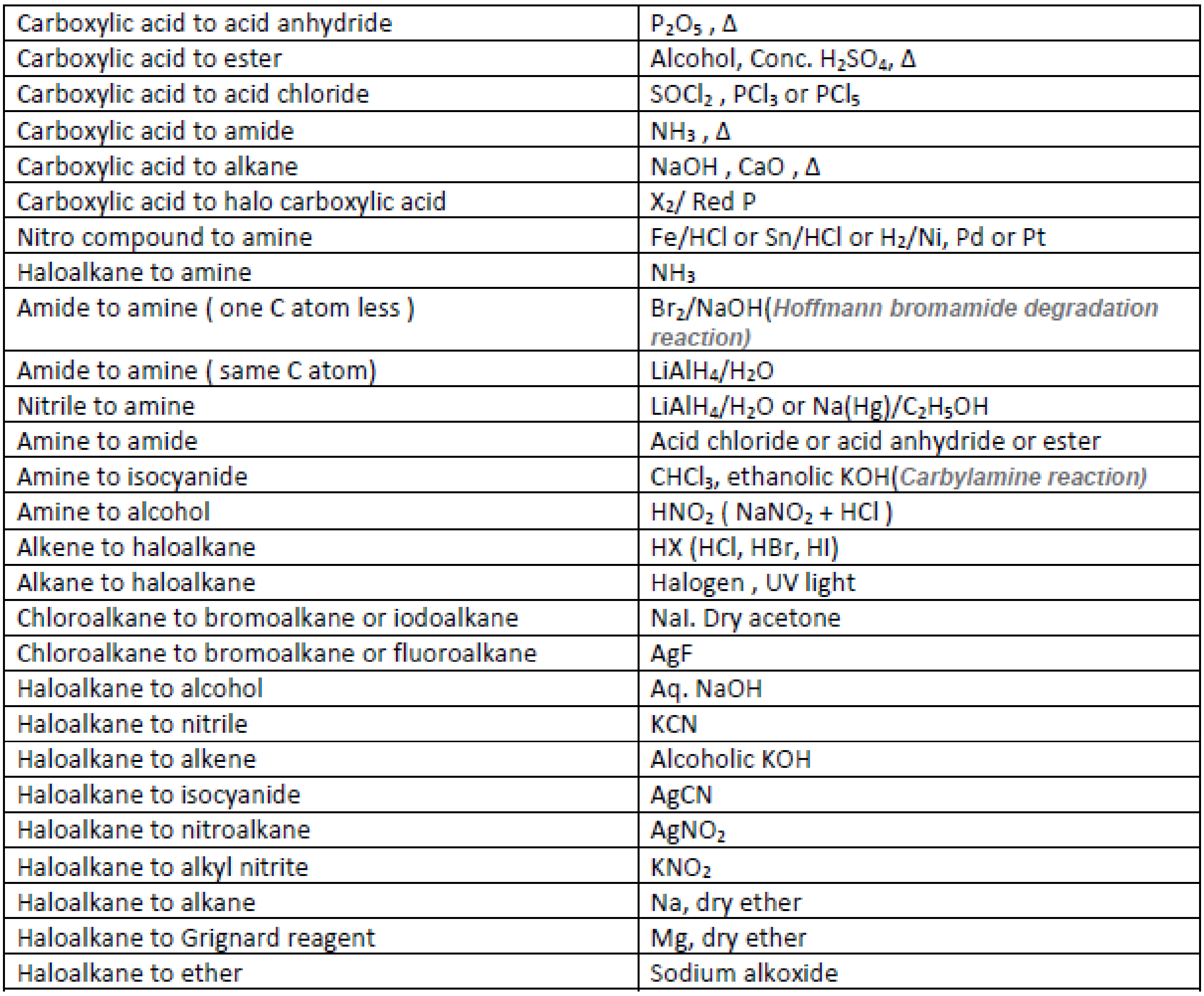
1,6-Dichlorobutane into hexane-1,6-diamine

$$Cl-(CH_2)_4-Cl \xrightarrow{KCN} NC-(CH_2)_4-CN \xrightarrow{LiAlH_4} H_2NH_2C-(CH_2)_4-CH_2NH_2$$

CONVERSION	**REAGENT**
Chlorobenzene to phenol	NaOH.H^+,623K,300atm
Benzene to phenol	Oleum, NaOH, H^+
Cumene to phenol	O_2, H^+, H_2O
Phenol to sodium phenoxide	NaOH
Phenol to o-nitrophenol and p-nitrophenol	Dil. HNO_3
Phenol to2,4,6-trinitro phenol	Conc. HNO_3, Conc. H_2SO_4
Phenol to 2,4,6-tribromophenol	Br_2 water
Phenol to o-bromophenol and p-bromo phenol	Br_2 in CS_2,273K(low polar solvent)
Phenol to salicylic acid	NaOH, CO_2, H+,400K,6atm,Kolbe-Schmidt reaction(Kolbe's reaction)
Phenol to salicylaldehyde	$CHCl_3$, aq NaOH, H^+,Reimer-Tiemann reaction
Phenol to benzene	Zn dust/Δ
Phenol to benzoquinone	$Na_2Cr_2O_7.H_2SO_4$
Anisole to o-bromoanisole and p-bromoanisole	Br_2 in CH_3COOH
Anisole to o-nitro anisole and p-nitro anisole	Conc. HNO_3, Conc. H_2SO_4
Anisole to 2-methoxy toluene and 4- methoxy toluene	CH_3Cl, anhydrous $AlCl_3$(F-C alkylation)
Anisole to 2-methoxyacetophenone and 4-methoxyacetophenone	CH_3COCl, anhydrous $AlCl_3$(F-C acylation)
Methyl iodide to anisole	Sodium phenoxide(C_6H_5ONa)
Benzoyl chloride to bezaldehyde	H_2, Pd/$BaSO_4$(Rosenmund reduction)
Toluene to benzaldehyde	1. CrO_2Cl_2, CS_2, H_3O^+(Etard reaction.) 2. CrO_3, $(CH_3CO)_2O$, H_3O^+
Benzene to benzaldehyde	CO, HCl, anhydrous $AlCl_3$/CuCl(*Gatterman – Koch reaction)*
Benzene to benzophenone	C_6H_5COCl, anhydrous $AlCl_3$(F-C benzoylation)
Benzene to acetophenone	CH_3COCl, anhydrous $AlCl_3$(F-C acylation)
Benzaldehyde to benzoic acid	$KMnO_4$-KOH/Δ,H_3O^+
Benzaldehyde to benzyl alcohol	$LiAlH_4$
Benzaldehyde to m- nitrobenzaldehyde	Conc. HNO_3, conc. H_2SO_4
Toluene to benzoic acid	Alkaline $KMnO_4$,Δ, H_3O^+
Ethyl benzene to benzoic acid	Alkaline $KMnO_4$,Δ, H_3O^+
Benzamide to benzoic acid	H_3O^+, Δ

Benzoyl chloride to benzoic acid	H_2O
Benzoic chloride to benzoyl acid	$SOCl_2$
Benzoic acid to benzamide	NH_3, Δ
Benzoic acid to m-nitro benzoic acid	Conc. HNO_3, Conc. H_2SO_4
Benzoic acid to m-bromo benzoic acid	$Br_2/FeBr_3$
Benzamide to aniline	Br_2/NaOH
Nitro benzene to aniline	Fe/HCl or Sn/HCl
Aniline to benzene diazonium salt	$NaNO_2$/HCl
Benzene to nitrobenzene	Conc. HNO_3, conc.H_2SO_4
Aniline to 2,4,6-tribromoaniline	Bromine water
Aniline to p-bromoaniline	$(CH_3CO)_2O$, Br_2 in CH_3COOH, H_2O
Aniline to p-nitroaniline	$(CH_3CO)_2O$, HNO_3, H_2SO_4, H_2O
Aniline to sulphanilic acid	Conc. H_2SO_4, Δ
Benzene diazonium salt to chlorobenzene	1.CuCl/HClSandmeyer reaction 2.Cu/HClGatterman reaction
Benzene diazonium salt to bromobenzene	1.CuBr/HBrSandmeyer reaction 2.Cu/HBr Gatterman reaction
Benzene diazonium salt to iodobenzene	KI
Benzene diazonium salt to fluorobenzene	HBF_4, Δ
Benzene diazonium salt to phenol	H_2O, warm
Benzene diazonium salt to benzene	H_3PO_2,H_2O
Benzene diazonium salt to cyanobenzene	CuCN/KCN Sandmeyer reaction
Benzene diazonium salt to nitrobenzene	HBF_4, $NaNO_2$, Cu, Δ
Benzene diazonium salt to p-hydroxy azobenzene	Phenol, OH-
Benzene daizonium salt to p-amino azobenzene	Aniline, OH-
Benzene to chlorobenzene	Cl_2, anhydrous $AlCl_3$
Benzene to bromobenzene	$Br_2/FeBr_3$
Chlorobenzene to 1,4-dichlorobenzene and 1,2-dichlorobenzene	Cl_2, anhydrous $AlCl_3$
Chlorobenzene to 1-chloro-2-nitrobenzene and 1-chloro-4-nitrobenzene	Conc. HNO_3, conc. H_2SO_4
Chlorobenzene to 2-chlorobenzene sulphonic acid and 4-chlorobenzene sulphonic acid	Conc. H_2SO_4, Δ
Chlorobenzene to 1-chloro-2-methyl benzene and 1-chloro-4-methyl benzene	CH_3Cl, anhydrous $AlCl_3$

Chlorobenzene to 2-chloroacetophenone and 4-chloroacetophenone	CH_3COCl, anhydrous $AlCl_3$
Chlorobenzene to methylebenzene	CH_3Cl, Na, dry ether
Chlorobenzne to diphenyl	Chlorobenzene, Na, Dry ether
Alkene to alcohol	1. H_2O/H^+ 2. B_2H_6, H_2O_2, H_2O, OH^-
Aldehyde to alcohol (same number of carbon atom)	1. $LiAlH_4$ (2) $NaBH_4$ (3) H_2/Pt.Ni or Pd
Carboxylic acid to alcohol	$LiAlH_4$, H_2O
Ester to alcohol	H_2/ Ni
Grignard reagent to primary alcohol	HCHO , H_3O^+
Grignard reagent to secondary alcohol	Other aldehydes, H_3O^+
Grignard reagent to tertiary alcohol	Ketone, H_3O^+
Alcohol to alkoxide	Metal (Na)
Alcohol to ester	Carboxylic acid, acid chloride or acid anhydride
Alcohol to haloalkane	$SOCl_2$, PX_3 or PCl_5
Alcohol to alkene	Conc. H_2SO_4 at 443K
Alcohol to aldehyde	PCC or CrO_3 or Cu catalyst/573K
Alcohol to carboxylic acid	$KMnO_4$
Secondary alcohol to ketone	CrO_3 or Cu catalyst
Tertiary alcohol to alkene	Cu catalyst
Alcohol to ether	Conc. H_2SO_4 at 413K
Haloalkane to ether	Sodium alkoxide
Ether to alcohol and haloalkane	HX (e.g. HI)
Alkene to aldehyde or ketone	O_3/Zn, H_2O
Alkyne to aldehyde or ketone	H_2O, $HgSO_4$, H_2SO_4
Acid chloride to aldehyde	H_2, , Pd/$BaSO_4$
Nitrile to aldehyde	1.$SnCl_2$, HCl, H_3O^+ (**Stephen** reaction) 2.DIBAL-H,H_2O (Wolff-Kishner reduction)
Acid chloride to ketone	R_2Cd
Nitrile to ketone	Grignard reagent, H_3O^+
Aldehyde or ketone to cyanohydrin	HCN
Aldehyde to acetal	Alcohol
Aldehyde or ketone to hydrocarbon	1.Zn(Hg) / Conc.HCl (Clemmensen reduction) 2.NH_2-NH_2, ethylene glycol, KOH,453-473K 3.HI/Red P at 423K
Aldehyde to carboxylic acid	$KMnO_4$ or $K_2Cr_2O_7$ or HNO_3
Ketone to carboxylic acid	$KMnO_4/H_2SO_4$,$K_2Cr_2O_7$/ H_2SO_4
Aldehyde or ketone to iodoform	NaOH and I_2(NaOI)
Nitrile to carboxylic acid	H_3O^+ (complete hydrolysis)
Nitrile to amide	H_3O^+ (partial hydrolysis)
Grignard reagent to carboxylic acid	CO_2 , H_3O^+
Acid anhydride to carboxylic acid	H_3O^+
Ester to carboxylic acid	H_3O^+



Carboxylic acid to acid anhydride	P_2O_5 , Δ
Carboxylic acid to ester	Alcohol, Conc. H_2SO_4, Δ
Carboxylic acid to acid chloride	$SOCl_2$, PCl_3 or PCl_5
Carboxylic acid to amide	NH_3 , Δ
Carboxylic acid to alkane	NaOH , CaO , Δ
Carboxylic acid to halo carboxylic acid	X_2/ Red P
Nitro compound to amine	Fe/HCl or Sn/HCl or H_2/Ni, Pd or Pt
Haloalkane to amine	NH_3
Amide to amine (one C atom less)	Br_2/NaOH(*Hoffmann bromamide degradation reaction)*
Amide to amine (same C atom)	$LiAlH_4/H_2O$
Nitrile to amine	$LiAlH_4/H_2O$ or Na(Hg)/C_2H_5OH
Amine to amide	Acid chloride or acid anhydride or ester
Amine to isocyanide	$CHCl_3$, ethanolic KOH(*Carbylamine reaction)*
Amine to alcohol	HNO_2 ($NaNO_2$ + HCl)
Alkene to haloalkane	HX (HCl, HBr, HI)
Alkane to haloalkane	Halogen , UV light
Chloroalkane to bromoalkane or iodoalkane	NaI. Dry acetone
Chloroalkane to bromoalkane or fluoroalkane	AgF
Haloalkane to alcohol	Aq. NaOH
Haloalkane to nitrile	KCN
Haloalkane to alkene	Alcoholic KOH
Haloalkane to isocyanide	AgCN
Haloalkane to nitroalkane	$AgNO_2$
Haloalkane to alkyl nitrite	KNO_2
Haloalkane to alkane	Na, dry ether
Haloalkane to Grignard reagent	Mg, dry ether
Haloalkane to ether	Sodium alkoxide

TONE-UP YOUR MEMORY –ORGANIC REASONING

1 # Which is more Reactive towards nucleophile by SN_2 **and why?**
(1-bromopentane , 2-bromopentane)
2# Which is more acidic and why? – (O-methoxy phenol , o-nitro phenol)
3# Which is more basic and why? (N-ethyl ehanamine , ethyl amine)
4# Which has more Boiling point and why? (n-propyl chloride , isopropyl chloride)
5# Which is more Reactive towards nucleophilic addition reaction and why?
(Acetal dehyde , propanone)
6# Which is more Reactive towards nucleophile by SN_1 . and why?
(cyclohexyl chloride , allyl chloride)
7# Which is more Reactive towards electrophile and why? (nitrobenzene , anisole)
8# Which has more bond angle and why? (Methanol ,Methoxy methane)
9# Which has more Boiling point and why? (Methanol , methanamine)
10# Which compound undergoes faster SN_1 reaction and why?
(Tert-butyl chloride and 3-chloropentane)
11# Which is more easily hydrolysed by aqueous KOH and why?
($C_6H_5CH_2Cl$ and $C_6H_5CHClC_6H_5$)
12# Gabriel phthalimide synthesis is preferred for synthesizing pure ------- and why?
(aliphatic primary amines .aromatic primary amines)
13# Which one is more soluble in water and why? (Ethylamine , aniline)
14# Whose pKb is more and why ? (aniline , methylamine)
15# Which one does not undergo Friedel-Crafts reaction and why? (Phenol , aniline)
16# Which has higher boiling point in isomeric cases and why ?

(primary amines, tertiary amines)?

17# Which is more easily nitrated and why? (Benzene and Phenol)

18# Which is steam volatile and why? (Ortho-nitrophenol , Para-nitrophenol)

19# Which is more acidic and why? (Phenol , ethanol)

20# Which is more acidic and why? (ortho-nitrophenol , para -nitrophenol)

21# Which is preferred for the preparation of alkyl chloride from alcohol and why?
(thionyl chloride , PCl_5 , Lucas Reagent)

22# Which is less reactive towards nucleophilic substitution reaction and why?
(C_6H_5Cl and $C_6H_{11}Cl$)

23# Which is more stable and why?
(Diazonium salts of aromatic amines , Diazonium salts of aliphatic amines) .

24# Which is more easily dehydrated and why? (sec-alcohol , tert-alcohol)

25# # In the following pairs of halogen compounds, which compound undergoes faster SN1 reaction and why? ?

26# In the following pairs of halogen compounds, which would undergo SN_2 reaction faster and why? ?

27# Pure primary amines are prepared through
(ammonolysis method , Gabriel phthalimide Synthesis)

28# Which acid of each pair shown here would you expect to be stronger and why? ?

(i) CH_3CO_2H or CH_2FCO_2H (ii) CH_2FCO_2H or CH_2ClCO_2H

(iii) $CH_2FCH_2CH_2CO_2H$ or $CH_3CHFCH_2CO_2H$ (iii) $F_3C—C_6H_4—COOH$ or $H_3C—C_6H_5—COOH$

29# Whose dipole moment is more and why? (chlorobenzene , Cyclohexyl chloride)

30#Which shows more reactivity in nucleophilic addition reactions and why? .
(Di-*tert*-butyl ketone, Methyl *tert*-butyl ketone)

31# Which has lowest K_b and why? (Aniline , *p*-nitroaniline and *p*-toluidine)

32# Which has highest boiling point and why?
(Pentan-1-ol , n-butane, pentanal , ethoxyethane.)

33# Which shows optical activity and why? (2-bromobutane , 1-bromobutane)

34# Which has higher Melting point and why? (p-dichlorobenzene , O-dichlorobenzene)

35# Which should be kept in closed dark coloured bottle and why?
(Chloroform , iodoform)

36# Which one shows highest reactivity towards HCN and why ?
(Benzaldehyde, *p*-Tolualdehyde, *p*-Nitrobenzaldehyde, Acetophenone.)

37# Which one has highest dipole moment and why? (CH_2Cl_2 , $CHCl_3$, CCl_4)

38# Which one easily get nitrated ? (Benzene , Phenol , Chlorobenzene , Nitrobenzene)

39# Which one will react faster in S_N2 reaction with OH^- and why?
(i) CH_3Br or CH_3I (ii) $(CH_3)_3CCl$ or CH_3Cl

40# “Greater the stability of carbocation , greater will be its ease of formation from alkyl halide and faster will be the rate of reaction”—

This statement better suits for (1^0 ,2^0 ,3^0 –halide) which leads to (S_N2 , S_N1) Reactions exclusively .

41# Which is more acidic . (2-methyl propan-2-ol , Butan-2-ol)

42# Which has highest basic character in aq. phase ?
[$C_2H_5NH_2$, $(C_2H_5)_2NH$, $(C_2H_5)_3N$ and NH_3]

43# Which one forms cyanohydrin in good yield and why?

(2,2,6-trimethylcyclohexanone , Cyclohexanone)

44# Which is less acidic and why ? (ethyl amine , ethyl alcohol)

45# Which is a stronger base and why ? (aliphatic amine , aromatic amine)

46# Which is better leaving group (chloride or iodide)

47# Which has the highest boiling point and why ?
(Bromomethane, Bromoform, Chloromethane, Dibromomethane)

48# Which would undergo SN_2 reaction faster and why ?
(1-chloro -1-cyclohexyl methane and cyclohexyl methane)

49# Which has more reactive towards nucleophilic substitution reaction
(Chlorobenzene , cyclohexyl chloride)

50# Which one will undergo racemisation when treated with aq. KOH in polar solvent and why ?
(Vinyl chloride ,methyl chloride , 2-chlorobutane)

51# Which has the most acidic character and why ?
(Benzoic acid, 4-Nitrobenzoic acid, 3,4-Dinitrobenzoic acid, 4-Methoxybenzoic acid)

52# Which is more acidic and why ?
(a) ($F_3C—C_6H_4—COOH$ or $H_3C—C_6H_5—COOH$) (b) (CH_3CO_2H or CH_2FCO_2H)

53# Which is more reactive towards Lucas Reagent (Propanol , isopropyl alcohol)

54# Which will undergo Friedel Craft reaction . (Anisole , Aniline)

55# Which is less acidic and why? (Methanamine , Methanol)

56# Which is more reactive towards HCN and why?
(Acetone , Acetaldehyde , Formaldehyde , Di-tert-butyl ketone)

57# Which is more acidic and why?
(Benzoic acid , 4-nitro benzoic acid , 4-methoxy benzoic acid)

58# Which has higher boiling point and why?
(ethanol , propane , propanoic acid , methoxymethane)

59# Which has highest solubility in water and why ? ($C_6H_5NH_2$, $(C_2H_5)_2NH$, $C_2H_5NH_2$)

60#Which has highest acidic character (Propan-1-ol, 2,4,6-trinitrophenol, 3-nitrophenol,
3,5-dinitrophenol, phenol, 4-methylphenol.)

61# Which has higher boiling point in isomeric cases and why ? (p-amines , t-amines)

62# Which one is preferred for preparing chloroalkanes from alcohol. (PCl_5 , $SOCl_2$)

63# Which has higher boiling point and why?
(Propanol , butane , propanone , Methoxy ethane)

64# Which one is more stable and why ?
(phenyl carbocation , benzyl carbocation , methyl carbocation , dimethyl carbocation)

65# Among the following most stable conjugate base is -----(phenoxide , acetate ,
fluoroacetate , 2-Fluoropropanoic acid , benzoate , trifluoroacetate)

66# Which one is easily reacts with aq. KOH at room temperature ?
(2,4 –dinitro chlorobenzene , 3,5 –dinitro chlorobenzene)

67# Which one will not gives foul smelling substance when treated with chloroform and alcoholic KOH ? (Aniline ,N-Mthyl methanamine , Ethanamine)

68# Which one shows turbidity immediately when treated with conc. HCl and anhyd. $ZnCl_2$ and why ?
(Butanol , butan-2-ol , tert-butyl alcohol)

69# Which is more reactive towards aq.NaOH
(Chlorobenzene , 1-chloro-2-nitrochlorobenzene)

70# Which one will respond positive iodoform test and why? (Etanol ,Methanol)

71# Which one undergo Canizzaro’s reaction . (Acetaldehyde , Benzaldehyde)

72# Which one undergo Aldol condensation themselves (acetaldehyde , formaldehyde)

73# What is the Major product of Etard’s Reaction (Salicylic acid ,benzaldehyde)

74# What could be the product of Gabriel Pthalimide reaction (Aniline , methyl amine)

75# Ethanol is converted to ethane in presence of conc.H_2SO_4 at what temp.
(413K ,443K)

76# Which reagent is used when phenol is converted into 2,4,6-tribromophenol
(Br_2 in CS_2 , Br_2 in Water)
77# What is the Major product of Reimer –Tiemann Reaction .
(Salicylic acid , Salicyldehyde)
78# Which one will give the iodoform test (acetophenone , benzophenone)
79# Which is a mild oxidizing agent ($KMnO_4$ /H^+ , PCC)
80# The major products formed 2-methyl -2-methoxy propane reacts with HI are --------------------------- and ---------------------

<u>ORGANIC NAME REACTIONS: CLASS XII- CHEMISTRY</u>

IDENTIFY THE FOLLOWING NAME REACTION AND COMPLETE THE FOLLOWING :-

1# $RCONH_2$ + Br_2 +aq KOH ------------→-------------- + -------------- + ------------- + -----

2# RNH_2 +$CHCl_3$ + Alc. KOH ---- (Warm)→--------------- + ------------------ + ---------------

3# $C_6H_5N_2Cl$ + [CuCl/HCl at 0^0C--]→----------------- + ------------ + -----------------

4# HCHO + HCHO ---- (50% NaOH)→------------------- + ---------------

5# RCOCl + H_2 ---[Pd/$BaSO_4$—Sulphur or Quinoline] →----------------- + -------------

6# CH_3CHO + dil NaOH → ------------------------

7# Phenol + $CHCl_3$ + aq.NaOH ---- [340 K] →----------------- + ---------------

8# Sodium Phenoxide +CO_2 --[400 K , 4-7 atm , H^+]→-----------------------

9# $C_6H_5CH_3$ + CrO_2Cl_2/CS_2 → -------------- ---[H_3O^+]→-----------------------

10# CH_3COOH + Red P/Cl_2 →-------------------------- + ---------------------

11# C_6H_5Cl + CH_3COCl --[Anh $AlCl_3$] →------------- + -----------------

12# CH_3MgBr + Acetone →---------------- ----[H_3O^+]→---------------- + -------------

13#CH_3CHO + 4 [H] -- [Zn-Hg / Conc.HCl] →------------------ + --------------------

14# ---------- ←<u>[CH_3Cl/Anhy $AlCl_3$]</u>— $\boxed{\text{BENZENE}}$ — <u>[CH_3COCl/Anhy $AlCl_3$]</u> →---------

15# CH_3COCH_3 + $H_2N–NH_2$ → ---------------- —[KOH / Glycol] →---------------

16# C_2H_5Br + $(CH_3)_3CO^- Na^+$ →-------------------- + ------------------------

17# Phthalimide + KOH →----------------------- — [RX]→ -------------- <u>+[OH^-]</u> →

18# Acetophenone + NaOH + I_2 → ----------------------- + ---------------

19# $C_6H_5N_2Cl$ + C_6H_5OH --[at 273-278 K] →

20# RCHO + $2[Ag(NH_3)_2]^+$ + $3OH^-$ → --------------- + --------------------- + ----------------
21# $C_6H_5N_2Cl$ + Cu powder / HCl → ----------------- + ------------------- + ------------------

22# $CH_3—CH=CH_2$ + BH_3 → ------------------------- —[H_2O_2 / OH^-]→ ------------------

23# CH_3Br + AgF / HgF_2 /CoF_2 /SbF_3 → ---------------- + ----------------------

24# $C_6H_5—Cl$ + Na + $Cl—CH_3$ —[Dry ether]→

25# RCN + $SnCl_2$ + HCl → ------------------------------- —[H_3O^+]→ ------------------

26# RCHO + 2Cu^{++} + 5 OH^{-} → ------------------- + ---------------- + ----------------

27#C_6H_6 + CO+ HCl → ………………………….. –(H_3O^+)→ …………….

28#CH_3Br +NaI (in presence of acetone) → ---------------- +--------------------

29# CH_3COONa + NaOH + CaO (heating) → ---------------------------- + -----------------------------

30 # $C_2H_5NH_2$ + $C_6H_5SO_2Cl$ → ------------------------------------- + -------------------------------------

31# CH_3COOH + C_2H_5OH --In presence of H^+ → ---------------------------------+ ----------------------

32# Tert- butyl alcohol + Conc . HCl + Anhyd.$ZnCl_2$ → ------------------------------ + ---------------------

33# 2-Chloropentane + Alcoholic KOH → --------------------(maj) + ----------------------(minor)

34# CH_3Br + NH_3 → -------------------- + ---

35# CH_3 CH=CH_2 + HBr → ------------------------------(maj) + -------------------------- (minor)

ARRAGE THE FOLLOWING WITH THE PROPERTIES MENTIONED***

1 # Arrange the following in increasing order of their basic strength:

(i) $C_2H_5NH_2$, $C_6H_5NH_2$, NH_3, $C_6H_5CH_2NH_2$ and $(C_2H_5)_2NH$

(ii) $C_2H_5NH_2$, $(C_2H_5)_2NH$, $(C_2H_5)_3N$, $C_6H_5NH_2$

(iii) CH_3NH_2, $(CH_3)_2NH$, $(CH_3)_3N$, $C_6H_5NH_2$, $C_6H_5CH_2NH_2$.

(iv) $C_6H_5NH_2$, $C_6H_5N(CH_3)_2$, $(C_2H_5)_2NH$ and CH_3NH_2

(v) Aniline, *p*-nitroaniline and *p*-toluidine

(vi) $C_6H_5NH_2$, $C_6H_5NHCH_3$, $C_6H_5CH_2NH_2$.

(vii) $C_2H_5NH_2$, $(C_2H_5)_2NH$, $(C_2H_5)_3N$ and NH_3 (in gas and aq.phase)

(viii) Explain the observed K_b order : $Et_2NH > Et_3N > EtNH_2$ (a) in aqueous solution & (b) in gas phase ?

(ix) In decreasing order of the *Kb* values: $C_2H_5NH_2$, $C_6H_5NHCH_3$, $(C_2H_5)_2NH$ and $C_6H_5NH_2$

Q.2#Which acid of each pair shown here would you expect to be stronger?

(i) CH_3CO_2H or CH_2FCO_2H (ii) CH_2FCO_2H or CH_2ClCO_2H (iii) $CH_2FCH_2CH_2CO_2H$ or $CH_3CHFCH_2CO_2H$

(iii) $F_3C—C_6H_4—COOH$ or $H_3C—C_6H_5—COOH$

Q.3 # Arrange the following compounds in increasing order of their acid strength:

(i) Propan-1-ol, 2,4,6-trinitrophenol, 3-nitrophenol, 3,5-dinitrophenol, phenol, 4-methylphenol.

(ii) ethanol , water, ethanoic acid , phenol

(iii) p-methoxy phenol , p-nitrophenol, phenol .

(iv) $CH_3CH_2CH(Br)COOH$, $CH_3CH(Br)CH_2COOH$, $(CH_3)_2CHCOOH$, $CH_3CH_2CH_2COOH$

(v) Benzoic acid, 4-Nitrobenzoic acid, 3,4-Dinitrobenzoic acid, 4-Methoxybenzoic acid

Q.4# Arrange the following compounds in increasing order of their reactivity in nucleophilic addition reactions.

(i) Ethanal, Propanal, Propanone, Butanone.

(ii) Benzaldehyde, *p*-Tolualdehyde, *p*-Nitrobenzaldehyde, Acetophenone.

(iii) Acetaldehyde, Acetone, Di-*tert*-butyl ketone, Methyl *tert*-butyl ketone (reactivity towards HCN)

Q.5# Arrange the following compounds in increasing order of their boiling points.

(i) CH_3CHO, CH_3CH_2OH, CH_3OCH_3, $CH_3CH_2CH_3$

(ii) $CH_3CH_2CH_2CHO$, $CH_3CH_2CH_2CH_2OH$, H_5C_2-O-C_2H_5, $CH_3CH_2CH_2CH_2CH_3$

(iii) Pentan-1-ol, butan-1-ol, butan-2-ol, ethanol, propan-1-ol, methanol. (iv) Pentan-1-ol , n-butane, pentanal , ethoxyethane.

(v) Acetaldehyde , ethanol , acetone , propane . (vi) Acetic acid , methyl formate , acetamide , propan-1-ol

(vii) diethylether, butanoic acid , butanol. (viii) Bromomethane, Bromoform, Chloromethane, Dibromomethane.

(ix) 1-Chloropropane, Isopropyl chloride, 1-Chlorobutane. (x) C_2H_5OH, $(CH_3)_2NH$, $C_2H_5NH_2$

(xi) In increasing order of solubility in water: $C_6H_5NH_2$, $(C_2H_5)_2NH$, $C_2H_5NH_2$.

Q.6# Predict the order of reactivity of the following compounds in S N1 and S_N2 reactions:

(i) The four isomeric bromobutanes (ii) $C_6H_5CH_2Br$, $C_6H_5CH(C_6H_5)Br$, $C_6H_5CH(CH_3)Br$, $C_6H_5C(CH_3)(C_6H_5)Br$

Q.7# Arrange the compounds of each set in order of reactivity towards SN_2 displacement:

(i) 2-Bromo-2-methylbutane, 1-Bromopentane, 2-Bromopentane

(ii) 1-Bromo-3-methylbutane, 2-Bromo-2-methylbutane, 2-Bromo-3-methylbutane

(iii) 1-Bromobutane, 1-Bromo-2,2-dimethylpropane, 1-Bromobutane, 1-Bromobutane.

.8# In the following pairs of halogen compounds, which would undergo SN_2 reaction faster?

Q.9 # In the following pairs of halogen compounds, which compound undergoes faster SN_1 reaction?

(i)

and

(ii)

and

Q**.10# write the major products formed by heating each of the following ethers with HI**

(a) $C_6H_5\text{-}CH_2—O—C_6H_5$ (b) $CH_3—CH_2—CH_2—O—C(CH_3)_2—CH_2—CH_3$

(c) $CH_3—CH_2—CH(CH_3)\text{--}\ CH_2—O—CH_2—CH_3$ (d) 2-methyl -2-methoxy propane

(e) Anisole

Q.11# Identify the major alkenes when the following alkyl haides with sodium ethoxide in ethanol

(i) 1-Bromo-1-methylcyclohexane (ii) 2-Chloro-2-methylbutane (iii) 2,2,3-Trimethyl-3-bromopentane

CBSE QUESTION PAPER SESSION 2024-26 56/2/1

General Instructions :

Read the following instructions carefully and follow them :

- *(i)* *This question paper contains* ***33*** *questions.* ***All*** *questions are* **compulsory**.
- *(ii)* *This question paper is divided into* ***FIVE*** *sections – Section* ***A, B, C, D*** *and* ***E***.
- *(iii)* ***Section A –*** *questions number* ***1*** *to* ***16*** *are multiple choice type questions. Each question carries* ***1*** *mark.*
- *(iv)* ***Section B –*** *questions number* ***17*** *to* ***21*** *are very short answer type questions. Each question carries* ***2*** *marks.*
- *(v)* ***Section C –*** *questions number* ***22*** *to* ***28*** *are short answer type questions. Each question carries* ***3*** *marks.*
- *(vi)* ***Section D –*** *questions number* ***29*** *and* ***30*** *are case-based questions. Each question carries* ***4*** *marks.*
- *(vii)* ***Section E –*** *questions number* ***31*** *to* ***33*** *are long answer type questions. Each question carries* ***5*** *marks.*
- *(viii)* *There is no overall choice given in the question paper. However, an internal choice has been provided in few questions in all the sections except Section –**A**.*
- *(ix)* *Kindly note that there is a separate question paper for Visually Impaired candidates.*
- *(x)* *Use of calculator is NOT allowed.*

You may use the following values of physical constants wherever necessary :

$c = 3 \times 10^{8}$ m/s
$h = 6.63 \times 10^{-34}$ Js
$e = 1.6 \times 10^{-19}$ C
$\mu_0 = 4\pi \times 10^{-7}$ T m A^{-1}
$\varepsilon_0 = 8.854 \times 10^{-12}$ C^2 N^{-1} m^{-2}

Mass of electron (m_e) = 9.1×10^{-31} kg.
1.675 10^{-27} kg.
1.673 10^{-27} kg.
Avogadro's number = 6.023×10^{23} per gram mole
Boltzmann's constant = 1.38×10^{-23} JK^{-1}

SECTION – A 16 × 1 = 16

Question No. **1** to **16** are Multiple Choice type questions carrying **1** mark each.

1. The charge required for the reduction of 1 mol of MnO_4^- to MnO_2 is

   (A) 1 F (B) 3 F

   (C) 5 F (D) 6 F

2. Which among the following is a false statement ?

   (A) Rate of zero order reaction is independent of initial concentration of reactant.

   (B) Half-life of a zero order reaction is inversely proportional to therate constant.

   (C) Molecularity of a reaction may be zero.

   (D) For a first order reaction, $t_{1/2} = 0.693/k$.

3. The number of molecules that react with each other in an elementary reaction is a measure of the :

   (A) activation energy of the reaction (B) stoichiometry of the reaction

   (C) molecularity of the reaction (D) order of the reaction

4. The element having $[Ar]3d^{10}4s^1$ electronic configuration is

   (A) Cu (B) Zn

   (C) Cr (D) Mn

5. The complex ions $[Co(NH_3)_5(NO_2)]^{2+}$ and $[Co(NH_3)_5(ONO)]^{2+}$ are called

   (A) Ionization isomers (B) Linkage isomers

   (C) Co-ordination isomers (D) Geometrical isomers

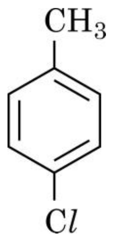
6. The diamagnetic species is :

   (A) $[Ni(CN)_4]^{2-}$ (B) $[NiCl_4]^{2-}$

   (C) $[Fe(CN)_6]^{3-}$ (D) $[CoF_6]^{3-}$

   [At. No. Co = 27, Fe = 26, Ni = 28]

7. Which is the correct IUPAC name for



(A) Methylchlorobenzene (B) Toluene

(C) 1–Chloro–4–Methylbenzene (D) 1–Methyl–4–Chlorobenzene

8. What will be formed after oxidation reaction of secondary alcohol with chromic anhydride (CrO_3) ?

(A) Aldehyde (B) Ketone

(C) Carboxylic acid (D) Ester

9. The conversion of phenol to salicylic acid can be accomplished by

(A) Reimer-Tiemann reaction (B) Friedel-Crafts reaction

(C) Kolbe reaction (D) Coupling reaction

10. Which of the following is/are examples of denaturation of protein ?

(A) Coagulation of egg white (B) Curdling of milk

(C) Clotting of blood (D) Both (A) and (B)

11. Nucleotides are joined together by

(A) Glycosidic linkage (B) Peptide linkage

(C) Hydrogen bonding (D) Phosphodiester linkage

12. Scurvy is caused due to deficiency of

(A) Vitamin B1 (B) Vitamin B2

(C) Ascorbic acid (D) Glutamic acid

For question number **13** to **16**, two statements are given – one labelled as Assertion (A) and the other labelled as Reason (R). Select the correct answer to these questions from the codes (A), (B), (C) and (D) as given below :

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).

(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).

(C) Assertion (A) is true, but Reason (R) is false.

(D) Assertion (A) is false, but Reason (R) is true.

13. **Assertion (A) :** In a first order reaction, if the concentration of the reactant is doubled, its half-life is also doubled.

    Reason (R) : The half-life of a reaction does not depend upon the initial concentration of the reactant in a first order reaction.

14. **Assertion (A) :** Cu cannot liberate H_2 on reaction with dilute mineral acids.

    Reason (R) : Cu has positive electrode potential.

15. **Assertion (A) :** Aromatic primary amines cannot be prepared by Gabriel Phthalimide synthesis.

    Reason (R) : Aryl halides do not undergo nucleophilic substitution reaction with the anion formed by phthalimide.

16. **Assertion (A) :** Vitamin D cannot be stored in our body.

    Reason (R) : Vitamin D is fat soluble vitamin and is not excreted from the body in urine.

SECTION – B

17. (A) The rate constant for a zero order reaction A → P is 0.0030 mol $L^{-1}s^{-1}$. How long will it take for the initial concentration of A to fall from 0.10 M to 0.075 M ? **2**

OR

(B) The decomposition of NH_3 on platinum surface is zero order reaction. What are the rates of production of N_2 and H_2 if $k = 2.5 \times 10^{-4}$ mol L^{-1} s^{-1} ? **2**

18. Define the following terms : **2 × 1**

(a) Pseudo first order reaction

(b) Half-life period of reaction ($t_{1/2}$)

19. Examine the following observations : **2 × 1**

(a) Transition elements generally form coloured compounds.

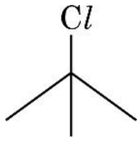
(b) Zinc is not regarded as a transition element.

20. Name the following coordination compounds according to IUPAC norms : **2 × 1**

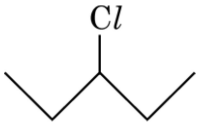
(a) $[Co(NH_3)_4(H_2O)Cl]Cl_2$

(b) $[CrCl_2(en)_2]\ Cl$

21. (a) In the following pair of halogen compounds, which compound undergoes S_N1 reaction faster and why ? **1**



and



(b) Arrange the following compounds in increasing order of their reactivity towards S_N2 displacement : **1**

2–Bromo–2–methylbutane, 1–Bromopentane, 2–Bromopentane.

SECTION – C

22. At 25 °C the saturated vapour pressure of water is 24 mm Hg. Find the saturated vapour pressure of a 5% aqueous solution of urea at the same temperature. (Molar mass of urea = 60 g mol^{-1}) **3**

23. The electrical resistance of a column of 0.05 M NaOH solution of area 0.8 cm^2 and length 40 cm is 5×10^3 ohm. Calculate its resistivity, conductivity and molar conductivity. **3**

24. Complete and balance the following chemical equations : **3 × 1**

    (a) $MnO_4^- + C_2O_4^{2-} + H^+ \longrightarrow$

    (b) $KMnO_4 \xrightarrow[513\ K]{}$

    (c) $Cr_2O_7^{2-} + H_2S + H^+ \longrightarrow$

25. Using valence bond theory, explain the hybridization and magnetic character of the following : **2 × 1½ = 3**

    (a) $[Co(NH_3)_6]^{3+}$

    (b) $[Ni(CO)_4]$

    [At. no. : Co = 27, Ni = 28]

26. (a) Define the following : **2 + 1 = 3**

    (i) Enantiomers

    (ii) Racemic mixture

    (b) Why is chlorobenzene resistant to nucleophilic substitution reaction ?

27. (A) Explain the following reactions and write chemical equation involved :

3 × 1 = 3

(a) Wolff-Kishner reduction

(b) Etard reaction

(c) Cannizzaro reaction

OR

(B) Write the structures of A, B and C in the following sequence of reactions : **2 × 1½ = 3**

(a) $CH_3COOH \xrightarrow{SOCl_2} A \xrightarrow{H_2,\ Pd\text{-}BaSO_4} B \xrightarrow{H_2N–NH_2} C$

(b) $CH_3CN \xrightarrow[2.\ H_2O]{1.(DIBAL–H)} A \xrightarrow{NaOH} B \longrightarrow$

28. Define the following terms : **3 × 1 = 3**

(a) Glycosidic linkage

(b) Invert sugar

(c) Oligosaccharides

SECTION – D

29. The spontaneous flow of the solvent through a semipermeable membrane from a pure solvent to a solution or from a dilute solution to a concentrated solution is called osmosis. The phenomenon of osmosis can be demonstrated by taking two eggs of the same size. In an egg, the membrane below the shell and around the egg material is semipermeable. The outer hard shell can be removed by putting the egg in dilute hydrochloric acid. After removing the hard shell, one egg is placed in distilled water and the other in a saturated salt solution. After some time, the egg placed in distilled water swells-up while the egg placed in salt solution shrinks. The external pressure applied to stop the osmosis is termed as osmotic pressure (a colligative property). Reverse osmosis takes place when the applied external pressure becomes larger than the osmotic pressure.

(a) Define reverse osmosis. Name one SPM which can be used in the process of reverse osmosis. **2**

(b) (i) What do you expect to happen when red blood corpuscles (RBC's) are placed in 0.5% NaCl solution ? **1**

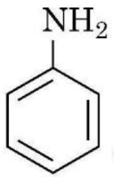
OR

(b) (ii) Which one of the following will have higher osmotic pressure in 1 M KCl or 1 M urea solution. Justify your answer. **1**

(c) Why osmotic pressure is a colligative property ? **1**

30. Amines have a lone pair of electrons on nitrogen atom due to which they behave as Lewis base. Greater the value of K_b or smaller the value of pK_b, stronger is the base. Amines are more basic than alcohols, ethers, esters, etc. The basic character of aliphatic amines should increase with the increase of alkyl substitution. But it does not occur in a regular manner as a secondary aliphatic amine is unexpectedly more basic than a tertiary amine in aqueous solutions. Aromatic amines are weaker bases than ammonia and aliphatic amines. Electron releasing groups such as $-CH_3$, $-OCH_3$, $-NH_2$, etc., increase the basicity while electron-withdrawing substituents such as $-NO_2$, $-CN$, halogens etc., decrease the basicity of amines. The effect of these substitute is more at p^- than at m^- position.

(a) Arrange the following in the increasing order of their basic character. Give reason : **2**



,

,

(b) Why pK_b of aniline is more than that of methylamine ? **1**

(c) (i) Arrange the following in the increasing order of their basic character in an aqueous solution : **1**

$(CH_3)_3N$, $(CH_3)_2NH$, NH_3, CH_3NH_2

OR

(c) (ii) Why ammonolysis of alkyl halides is not a good method to prepare pure amines ? **1**

SECTION – E

31. (A) (a) Give IUPAC name of $CH_3 - CH = CH - CHO$. **1**

(b) Give a simple chemical test to distinguish between propanal and propanone. **1**

(c) How will you convert the following : **3**

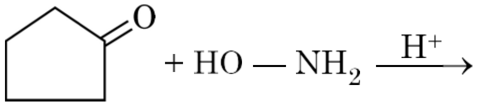
(i) Toluene to benzoic acid

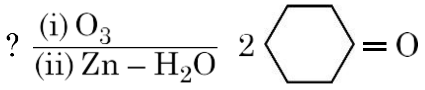
(ii) Ethanol to propan–2–ol

(iii) Propanal to 2–hydroxy propanoic acid

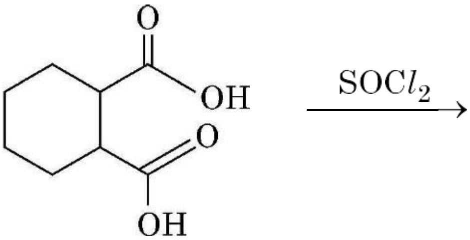
OR

31. (B) Complete each synthesis by giving missing starting material, reagent or products : **5 × 1 = 5**

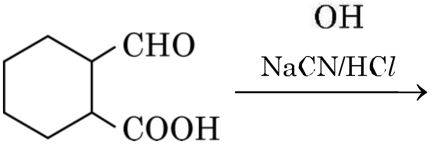
(a) 

(b) 

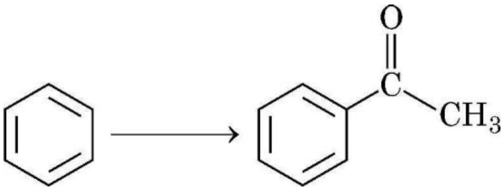
c)



(d)



(e)



32. (A) (a) Calculate the standard Gibbs energy ($\Delta_r G^\circ$) of the following reaction at 25 °C : **3 + 2**

$Au(s) + Ca^{2+}(1M) \rightarrow Au^{3+}(1M) + Ca(s)$

$E^\circ_{Au^{3+}/Au} = +1.5$ V, $E^\circ_{Ca^{2+}/Ca} = -2.87$ V

Predict whether the reaction will be spontaneous or not at 25 °C.

[1 F = 96500 C mol^{-1}]

(b) Tarnished silver contains Ag_2S. Can this tarnish be removed by placing tarnished silverware in an aluminium pan containing an inert electrolytic solution such as NaCl ? The standard electrode potential for half reaction :

$Ag_2S(s) + 2e^- \longrightarrow 2Ag(s) + S^{2-}$ is -0.71 V and for

$Al^{3+} + 3e^- \longrightarrow 2Al(s)$ is -1.66 V

OR

32. (B) (a) Define the following : **2 + 3**

(i) Cell potential

(ii) Fuel cell

(b) Calculate emf of the following cell at 25 °C :

$$Zn(s) | Zn^{2+}_{(0.1M)} || Cd^{2+}_{(0.01M)} | Cd(s)$$

Given : $E^{o}_{Cd^{2+}/Cd} = -0.40$ V

$E^{o}_{Zn^{2+}/Zn} = -0.76$ V

[log 10 = 1]

33. (A) An organic compound ‘A’, molecular formula C_2H_6O oxidises with CrO_3 to form a compound ‘B’. Compound ‘B’ on warming with iodine and aqueous solution of NaOH gives a yellow precipitate of compound ‘C’. When compound ‘A’ is heated with conc. H_2SO_4 at 413 K gives a compound ‘D’, which on reaction with excess HI gives compound ‘E’. Identify compounds ‘A’, ‘B’, ‘C’, ‘D’ and ‘E’ and write chemical equations involved. **5**

OR

33. (B) (a) Write chemical equations of the following reactions : **3 + 1 + 1 = 5**

(i) Phenol is treated with conc. HNO_3

(ii) Propene is treated with B_2H_6 followed by oxidation by H_2O_2/OH^-.

(iii) Sodium t-butoxide is treated with CH_3Cl.

(b) Give a simple chemical test to distinguish between butan–1–ol and butan–2–ol.

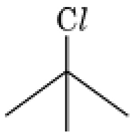
(c) Arrange the following in increasing order of acid strength :
phenol, ethanol, water

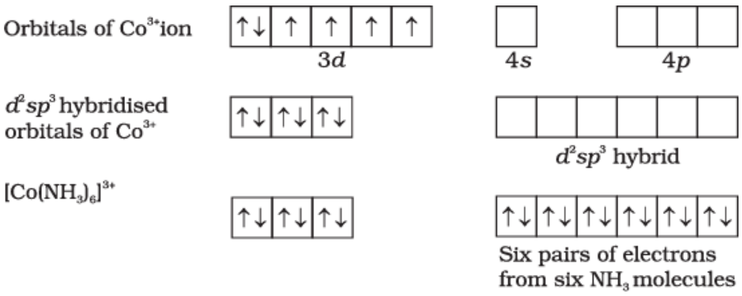
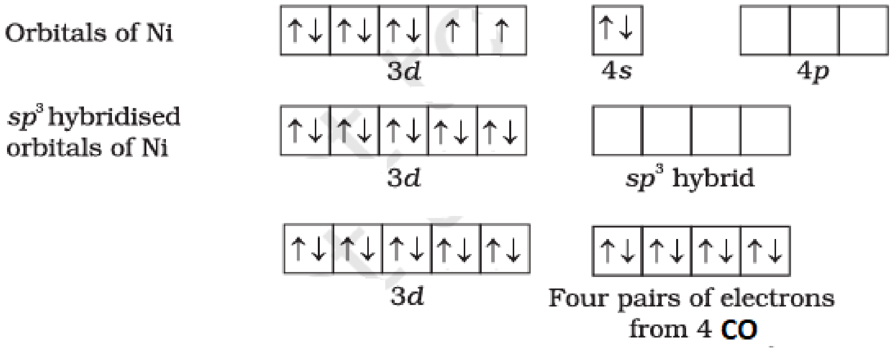
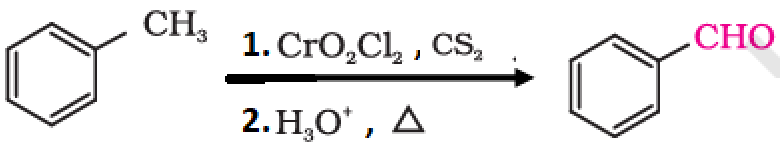
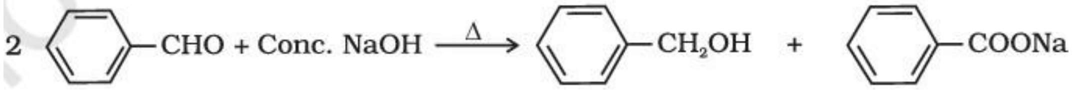
MARKING SCHEME 2024-25

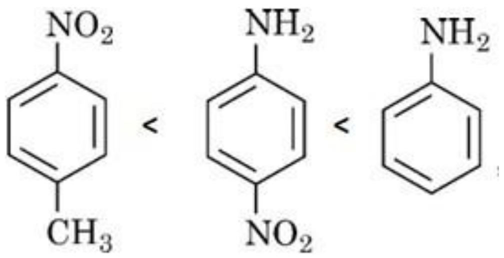
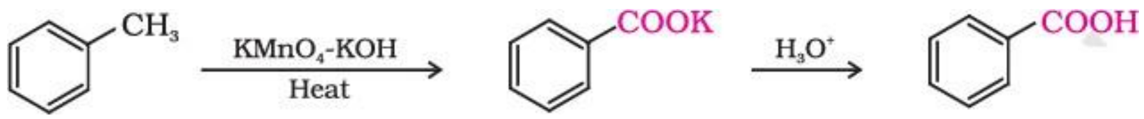
CHEMISTRY (Theory)- 043

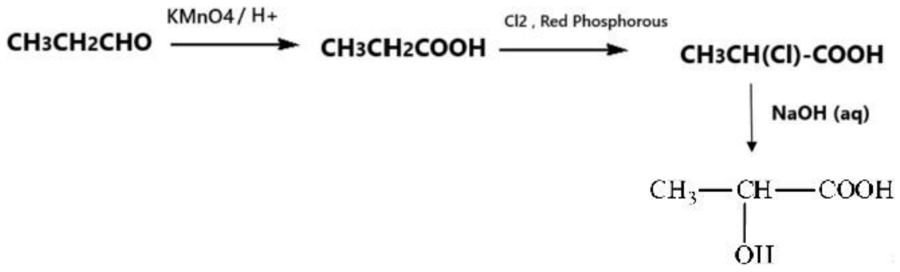
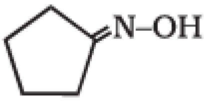
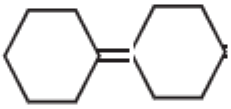
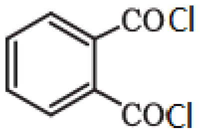
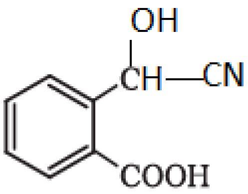
QP CODE 56/2/1 MM: 70

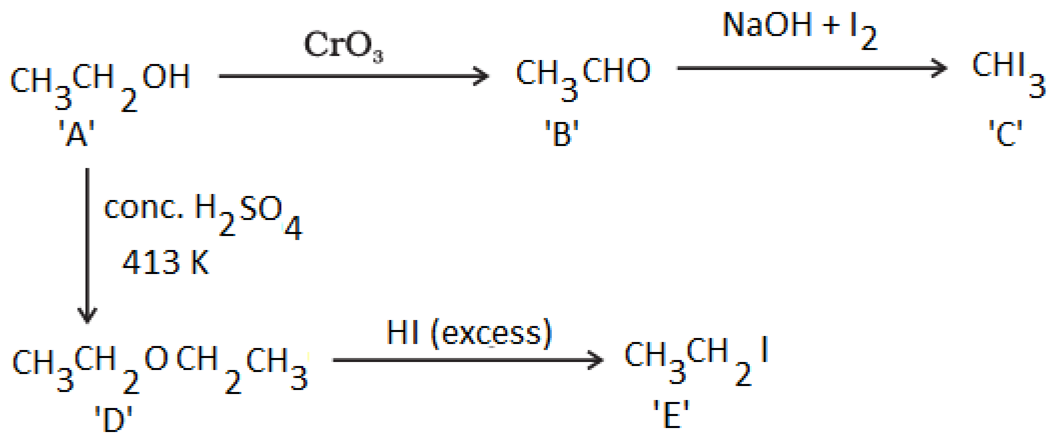
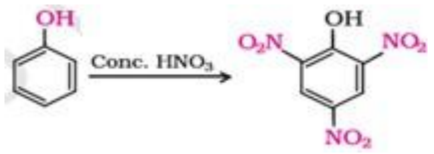
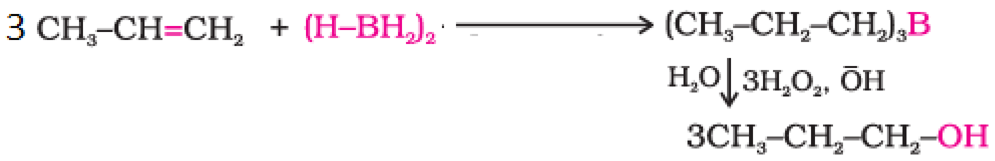
Q. No.	Value points	Mark
	SECTION A	
1	(B)	1
2	(C)	1
3	(C)	1
4	(A)	1
5	(B)	1
6	(A)	1
7	(C)	1
8	(B)	1
9	(C)	1
10	(D)	1
11	(D)	1
12	(C)	1
13	(D)	1
14	(A)	1
15	(A)	1
16	(D)	1
	SECTION B	
17	$k = \frac{[R]_0 - [R]}{t}$ $t = \frac{0.10 - 0.075}{0.0030}$ $t = \frac{0.025}{0.0030}$ $t = 8.33\ s$	½ 1 ½
	OR	
17	$\text{Rate} = \frac{-1}{2}\frac{\Delta[NH3]}{\Delta t} = \frac{\Delta[N2]}{\Delta t} = \frac{+1}{3}\frac{\Delta[H2]}{\Delta t}$ $\frac{-1}{2}\frac{\Delta[NH3]}{\Delta t} = \frac{\Delta[N2]}{\Delta t} = \frac{+1}{3}\frac{\Delta[H2]}{\Delta t} = k$ $\frac{\Delta[N2]}{\Delta t} = 2.5 \times 10^{-4}\ \text{mol L}^{-1}\ \text{s}^{-1}$ $\frac{\Delta[H2]}{\Delta t} = 3 \times 2.5 \times 10^{-4}$ $= 7.5 \times 10^{-4}\ \text{mol L}^{-1}\ \text{s}^{-1}$	½ ½ ½ ½
18	(a) The reaction that seems to be of higher order but under certain conditions is of first order. (b) The time in which the concentration of a reactant is reduced to one half of its initial concentration / The time in which half of the reaction is completed.	1 1
19	(a) Due to the presence of unpaired electron in d sub shell/ due to d-d transition. (b) Due to the presence of fully filled d- subshell in ground state and oxidized state.	1 1
20	(a) Tetraammineaquachloridocobalt(III) chloride (b) Dichloridobis(ethane-1,2-diamine)chromium(III) chloride	1 1

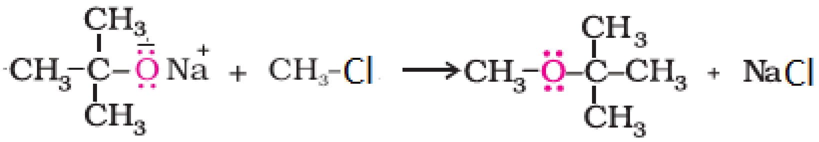
21	(a)  , due to the formation of more stable tertiary carbocation. (b) 2-Bromo-2-methylbutane < 2-Bromopentane < 1-Bromopentane.	½ , ½ 1
	SECTION C	
22	$\frac{p_1^0 - p_1}{p_1^0} = \frac{w_2 \times M_1}{M_2 \times w_1}$ $\frac{24 - p_1}{24} = \frac{5 \times 18}{60 \times 95}$ $\frac{24 - p_1}{24} = \frac{3}{190}$ $24 - p_1 = \frac{3 \times 24}{190}$ $p_1 = 23.62$ mm Hg / 23.64 mm Hg (Deduct ½ mark for no or incorrect unit).	1 1 1
23	$\rho = \frac{RA}{l}$ $= \frac{5 \times 10^3 \times 0.8}{40}$ $= 100\ \Omega$ cm $\kappa = \frac{1}{\rho}$ $= \frac{1}{100}$ $= 10^{-2}$ S cm^{-1} $\Lambda_m = \frac{\kappa \times 1000}{C}$ $= \frac{10^{-2} \times 1000}{0.05}$ $= 2 \times 10^2$ S cm^2 mol^{-1}	½ ½ ½ ½ ½ ½
24	(a) $5C_2O_4^{2-} + 2MnO_4^- + 16H^+ \longrightarrow 2Mn^{2+} + 8H_2O + 10CO_2$ (b) $2KMnO_4 \rightarrow K_2MnO_4 + MnO_2 + O_2$ (c) $Cr_2O_7^{2-} + 8H^+ + 3H_2S \rightarrow 2Cr^{3+} + 3S + 7H_2O$	1 1 1

25	(a)  Hybridization: d^2sp^3 **Magnetic character: Diamagnetic.** (b)  **Hybridization: sp^3** **Magnetic character: Diamagnetic.**	½ ½ ½ ½ ½ ½
26.	(a) (i) The stereoisomers related to each other as non-superimposable mirror images. (ii) A mixture containing dextro and laevo enantiomers in equal proportions. (b) C—Cl bond acquires a partial double bond character due to resonance / the carbon atom of benzene attached to halogen is sp^2-hybridised / Explanation through resonating structures.	1 1 1
27	(A) (a) The carbonyl group of aldehydes and ketones is reduced to CH_2 group on treatment with hydrazine followed by heating with sodium or potassium hydroxide in high boiling solvent such as ethylene glycol  (b) Chromyl chloride oxidises methyl group of toluene to a chromium complex, which on hydrolysis gives corresponding benzaldehyde.  (c) Aldehydes which do not have α-hydrogen atom, undergo self-oxidation and reduction reaction on heating with concentrated alkali gives salt of carboxylic acid and alcohol  (Or any other example)	½ ½ ½ ½ ½ ½
	OR	
27	(B) (a) A = CH_3COCl (b) CH_3CHO (c) $CH_3CH=NNH_2$	½ x 3

	(b) A = CH_3CHO (b) $CH_3CH(OH)CH_2CHO$ (c) $CH_3CH=CHCHO$	½ x 3
28	(a) The oxide linkage between two monosaccharides. (b) Hydrolysis of sucrose brings about a change in the sign of rotation, from dextro (+) to laevo (–) and the product is named as invert sugar. (c) Carbohydrates that yield two to ten monosaccharide units, on hydrolysis.	1 1 1
	SECTION D	
29	(a) • When external pressure is larger than the osmotic pressure, then the movement of solvent is from solution to solvent side through semi permeable membrane. / The direction of osmosis can be reversed if a pressure larger than the osmotic pressure is applied to the solution side. • Cellulose acetate / Or any other suitable example. (b) (i) RBC swells up / Cells swell and may even burst due to endo-osmosis. **OR** (ii) 1 M KCl, i = 2 / KCl dissociates into ions, whereas urea does not dissociate. (c) It depends upon the number of solute particles in the solution.	1 1 1 ½ ½ 1
30	(a)  / Award full marks if attempted because of printing error. (b) Due to resonance in aniline the lone pair of electrons are less available while they are easily available in methyl amine. (c) (i) $NH_3 < (CH_3)_3N < CH_3NH_2 < (CH_3)_2NH$ OR (ii) A mixture of primary, secondary and tertiary amines and also a quaternary ammonium salt is formed.	2 1 1
	SECTION E	
31	(a) But-2-enal (b) On heating with NaOH + I_2, propanone gives yellow ppt. Of iodoform (CHI_3) whereas propanal does not. (Or any other suitable chemical test) (c) (i)  (ii) $CH_3CH_2OH \xrightarrow{PCC} CH_3CHO \xrightarrow[2.\ H_3O^+]{1.\ CH_3MgBr} CH_3CH(OH)CH_3$	1 1 1 1

	(iii)  (Or any other correct method)	1
	OR	
31	(B) (a)  (b)  (c)  (d)  (e) CH_3COCl / Anhy. $AlCl_3$ or $(CH_3CO)_2O$/ Anhy. $AlCl_3$	1 × 5= 5
32	(A) (a) $E^o_{cell} = E^o_{cathode} - E^o_{anode}$ $= - 2.87 - 1.5$ V $=$ **$- 4.37$ V** $\triangle G^0 = - nF E^o_{cell}$ $= -6 \times 96500 \times (-4.37)$ $= 2530.230$ kJ/mol Reaction is non-spontaneous. (b) Yes, the tarnish can be removed. Aluminium has more negative standard electrode potential than silver so will reduce silver sulphide to silver, tarnish will be removed. **/** $3 Ag^+ + Al \longrightarrow 3 Ag + Al^{3+}$ $E^o_{cell} = E^o_{cathode} - E^o_{anode}$ $= - 0.71 - (-1.66)$ V $= 0.95$ V This indicates that the reaction is feasible and tarnish can be removed.	 ½ ½ 1 1 1 1

	OR	
32	(B) (a) (i) Potential difference between two electrodes of a galvanic cell. (ii) The galvanic cell in which combustion energy of fuels is directly converted into electrical energy. b) n =2 $E^o_{cell} = E^o_{cathode} - E^o_{anode}$ $= -0.40 - (-0.76)$ V = 0**.36 V** $E_{Cell} = E^o_{celi} - \frac{0\cdot059}{2} \log [\frac{Zn^{2+}}{Cd^{2+}}]$ $= [0.36] - \frac{0\cdot059}{2} \log \frac{0\cdot1}{0\cdot01}$ $= (0\cdot36 - 0\cdot0295)$ = **0·3305 V** (Deduct ½ mark for no or incorrect unit)	1 1 1 1 1
33	**(A) A =** CH_3CH_2OH / Ethanol / Ethyl alcohol, B = CH_3CHO / Ethanal / Acetaldehyde, C = CHI_3 / Iodoform / Triiodomethane, D = $CH_3CH_2O\ CH_2\ CH_3$ / Ethoxyethane / Diethyl ether, E = CH_3CH_2I / Ethyl iodide / Iodoethane. 	½ x 5 ½ x 5
	OR	
33	(B) (a) (i)  (ii)  (iii)	1 1 1

	 $CH_3-\underset{CH_3}{\overset{CH_3}{C}}-\overset{-}{\ddot{O}}\,\overset{+}{Na} + CH_3-Cl \longrightarrow CH_3-\ddot{O}-\underset{CH_3}{\overset{CH_3}{C}}-CH_3 + NaCl$ (b) On heating with NaOH + I_2, Butan-2-ol gives yellow ppt. Of iodoform (CHI_3) whereas Butan-1-ol does not. (Or any other suitable chemical test) (c) Ethanol < Water < Phenol.	1 1